Distribution and Relative Abundance of Cetaceans in Western Canadian Waters From Ship Surveys, 2002-2008

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DISTRIBUTION AND RELATIVE ABUNDANCE OF CETACEANS IN WESTERN CANADIAN WATERS FROM SHIP SURVEYS, 2002-2008

by

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ABSTRACT

Ford, J.K.B., Abernethy, R.M., Phillips, A.V., Calambokidis, J., Ellis, G.M., and Nichol, L.M. 2010. Distribution and relative abundance of cetaceans in western Canadian waters from ship surveys, 2002-2008. Can. Tech. Rep. Fish. Aquat. Sci. 2913: v + 51 p.

A total of 21 ship surveys were undertaken during 2002-2008 to investigate the occurrence, relative abundance and habitat use patterns of cetaceans in waters off the Pacific coast of Canada. These surveys were focused on species listed under Canada's Species at Risk Act (SARA) though sightings of all cetaceans were recorded systematically. Surveys averaged 12.5 days in duration (range 6-23 days) and were conducted primarily from Canadian Coast Guard ships and occasionally from a private charter vessel. They were undertaken in all seasons with most effort during spring and summer. A total of 1,815 hours of survey effort over a distance of 29,890 km was completed. This effort resulted in 2,862 sightings of a total of 15 cetacean species. Most frequently sighted species were, in order, humpback whale, Dall's porpoise, fin whale, Pacific white-sided dolphin, and harbour porpoise. Ten species known to occur in waters of British Columbia were not sighted, including SARA-listed North Pacific right whale and sei whale. Although this survey effort was considerable, additional systematic line-transect surveys over longer periods and in offshore waters would be needed for a quantitative assessment of cetacean abundance over Canada's entire exclusive economic zone (EEZ) off the Pacific coast.

RÉSUMÉ

Ford, J.K.B., Abernethy, R.M., Phillips, A.V., Calambokidis, J., Ellis, G.M., and Nichol, L.M. 2010. Distribution and relative abundance of cetaceans in western Canadian waters from ship surveys, 2002-2008. Can. Tech. Rep. Fish. Aquat. Sci. 2913: v + 51 p.

De 2002 à 2008, un total de 21 relevés ont été réalisés à bord de navires pour étudier l'occurrence et l'abondance relative des cétacés, de même que la façon dont ils utilisent leur habitat, dans les eaux canadiennes situées au large de la côte Pacifique. Ces études s'intéressaient aux espèces visées par la *Loi sur les espèces en péril* (LEP) du Canada, mais toutes les observations de cétacés ont été systématiquement notées. Les relevés duraient en moyenne 12,5 jours (de 6 à 23 jours); ils ont été effectués en majeure partie à bord de navires de la Garde côtière canadienne, et parfois à bord de navires affrétés privés. Des relevés ont été réalisés toutes les saisons, mais les activités étaient plus intenses durant le printemps et l'été. Les relevés ont été effectués pendant 1 815 heures au total, sur une distance de 29 890 km. Ainsi, on a relevé 2 862 observations de cétacés représentant 15 espèces. Les espèces les plus fréquemment observées étaient, dans l'ordre, le rorqual à bosse, le marsouin de Dall, le rorqual commun, le dauphin à flancs blancs du Pacifique et le marsouin commun. Dix espèces dont la présence est connue dans les eaux de la Colombie-Britannique n'ont pas été observées, notamment la baleine noire du Pacifique Nord et le rorqual boréal, deux espèces visées par la LEP. Malgré l'intensité des activités de recherche, des relevés systématiques additionnels effectués le long de transects sur de longues périodes et au large seraient nécessaires pour quantifier l'abondance des cétacés dans l'ensemble de la zone économique exclusive (ZEE) du Canada au large de la côte Pacifique.

1.0 INTRODUCTION

There is a wide diversity of marine habitats off the west coast of Canada, including long, deep fjords and channels, protected coastal seas, outer continental shelf areas with submarine canyons, and offshore pelagic waters. As a result, British Columbia has a particularly rich and varied cetacean fauna. A total of 25 species of whales, dolphins and porpoises have been documented in these waters. Some, such as the beaked whales, are restricted to remote offshore waters and only a few sighting records exist in the province. Others, such as killer whales and grey whales, can frequently be found nearshore in populated areas, where they are the focus of whale watch operations.

Although numerous field studies have focused on particular cetacean species in British Columbia (BC) waters, most have been conducted in nearshore waters from small vessels and very few have been multi-species surveys to determine general seasonal distribution and abundance. Ford et al. (1994) undertook cetacean surveys in the nearshore waters of Gwaii Haanas National Park Reserve, Haida Gwaii, during the summers of 1990-1992. Keple (2002) conducted weekly surveys along a BC Ferry corridor across the Strait of Georgia during 2000. Systematic line-transect boat surveys of marine mammals in the inshore waters of the BC coast were undertaken during 2004-05 by Williams and Thomas (2007). Other than these surveys, most information on cetacean occurrence in BC waters comes from opportunistic sightings and strandings (e.g., Pike and MacAskie 1968; Willis and Baird 1998) and from analyses of historical whaling data (Gregr et al. 2000; Gregr and Trites 2001).

Since 2002, the Cetacean Research Program (CRP) has conducted shipboard surveys aimed at determining the seasonal distribution, relative abundance and habitat use patterns of cetaceans in waters off the Pacific coast of Canada. This information is needed to provide scientific advice for the development of recovery strategies and action plans for the eight cetacean species and/or populations that are listed under Canada's Species at Risk Act (SARA). These species include North Pacific right whale (*Eubalaena japonica*, Endangered) blue whale (*Balaenoptera musculus*, Endangered), sei whale (*Balaenoptera borealis*, Endangered), fin whale (*Balaenoptera physalus*, Threatened), humpback whale (*Megaptera novaeangliae*, Threatened), and three populations of killer whale (*Orcinus orca*): southern resident (Endangered), northern resident (Threatened) and transient (Threatened). Survey cruises were undertaken using a variety of DFO Science ships, mostly while the vessels were dedicated to this task but occasionally while the ships were undertaking other operations, such as search and rescue patrols. Some surveys were conducted in collaboration with Cascadia Research Collective (Olympia, WA) using a charter vessel.

In this report, we describe cetacean sightings made during 21 survey cruises undertaken off the BC coast between 2002 and 2008. Some survey effort was applied in all regions of the coast over the course of these years, but to most effectively use available ship time, effort during each survey was typically focused in areas considered

likely to contain SARA-listed cetaceans based on historical whaling records, incidental sighting reports, or results of earlier surveys in the series. When concentrations of whales were found and sea conditions were favourable, small boats were deployed for the collection of individual identification photographs for studies of population abundance, movement patterns and site fidelity (e.g., Calambokidis et al. 2008, 2009; Rambeau 2008; Ford et al. 2009; Nichol et al. 2009) and biopsy samples for studies of population genetics and contaminants. When animals were observed feeding, attempts were made to obtain evidence of prey species, either by collection of whole prey (e.g., zooplankton) or prey fragments (e.g., fish scales or tissue; Ford and Ellis 2006). Strict sampling protocols were maintained during surveys to ensure consistent collection of sighting data and sighting effort (Buckland et al. 2001). Sighting rates by distance surveyed are thus broadly comparable across coastal regions and surveys.

2.0 MATERIALS AND METHODS

2.1 STUDY AREA

Surveys covered a range from 48°N to 54°N (the length of Canada's Pacific coast) and from 123°W to 133°W. Effort was concentrated in waters off Haida Gwaii (Queen Charlotte Islands), northern Vancouver Island, and the north mainland coast, as well as in Dixon Entrance, Hecate Strait and Queen Charlotte Sound (Fig. 1; for map of place names, see Appendix A). No surveys extended beyond approximately 150 km of the continental shelf break.

2.2 SURVEY TIMING

A total of 21 dedicated cetacean ship surveys were conducted during 2002-2008 (Table 1). Surveys averaged 12.5 days duration, with a range of 6-23 days. Three surveys were undertaken during winter (January-March, 2006-2008), seven during spring (April-June, 2002 to 2008), seven during summer (July-September, 2002 to 2008) and four in fall (October-December, 2003, 2004, 2006, 2007). Summer surveys in 2002 to 2007 were conducted in collaboration with Cascadia Research Collective (Olympia, WA).

2.3 DESCRIPTION OF VESSELS

The cetacean surveys employed primarily Canadian Coast Guard (CCG) research vessels, with the exception of the joint DFO / Cascadia Research surveys that used a chartered vessel, the M/V *Curve of Time*. Descriptions of vessels and survey personnel are summarized in Appendix B.

2.4 CETACEAN OBSERVATION

Prior to 2006, all data were recorded onto data forms by hand. Definitions of data fields and codes and an example of the data sheet are provided in Appendix C.

In 2006, CRP began collecting data electronically using the automatic data logging program Logger 2000® (produced by the International Fund for Animal Welfare). With the introduction of this technology some changes to survey protocol were made and will be described where relevant. Definitions of data fields and codes used with the Logger 2000® program are provided in Appendix D.

2.4.1 Platforms used for observation

On all CCG vessels except the CCGS *W.E. Ricker*, survey observers were positioned primarily on the roof of the ship's wheelhouse, also known as the "monkey's island". Two observers were on shift at a time, and were positioned parallel to each other on the port and starboard sides of the monkey's island. Observers relayed sighting information via FRS radio to a data recorder on the bridge, who entered information onto data sheets or Logger 2000®. During periods of rain, observers often observed from each side of the wheelhouse rather than the monkey's island. All observations on the CCGS *W.E. Ricker* were made from the wheelhouse, as the ship has no useable monkey's island.

On the M/V *Curve of Time*, two observers maintained watch from the ship's bow and a third observer watched from a crow's nest atop the ship's mast.

2.4.2 Equipment used for observation

Observers employed either Fujinon® 7x50 binoculars with reticles, or Fujinon® 25x150 MTM heavy duty military binoculars with reticles ("big eyes") that were pedestal-mounted on the vessel's monkey's island or observation deck. Prior to 2006, the navigation program Nobletec® was used to collect a survey track. Throughout each survey, position and weather data (relative wind speed/direction) were also collected from the ship's instrumentation. With the introduction of Logger 2000 for data recording, the ship's position, speed, and heading were collected automatically every 30 seconds, or when prompted for sighting positions, utilizing a US GlobalSat® BU-353 USB GPS.

2.4.3 Survey effort

Effort was defined as 'on' when observers were on watch, weather was favourable (Beaufort sea state < 5 and visibility > 1 nm), and the ship was travelling at > 5 kts. With the introduction of Logger 2000, visibility was further classified into excellent (clear horizon, excellent lighting), good (clear horizon), fair (no horizon, > 3 nm visibility), and poor (< 3 nm of visibility). Effort was listed as 'off' when no observers were

available, when weather deteriorated (sea state ≥ 5, visibility < 1 nm) and when the ship slowed or stopped (e.g., to launch the small boats or for non-survey related ship activities). In the case of poor weather, scanning often continued and sightings were recorded as off-effort. Only on-effort sightings are included in this report.

Beginning in 2003, survey effort was further classified into "passing" or "closing" modes (Barlow 1997). Most surveys were conducted in passing mode, in which the ship continued along predetermined headings regardless of cetacean sightings. When circumstances warranted further investigation of a particular sighting, the ship was diverted towards the individual or group and effort was listed as closing mode until the ship returned to the original heading. For the purposes of this report, effort classified as 'on' is considered to be in passing mode. Only sightings made in passing mode are included in this report.

2.4.4 Cetacean sighting protocols

While on effort, two observers were positioned outside on each side of the designated observation deck, or inside the ship's wheelhouse. Observers followed a scheduled rotation of 30 minutes scanning on the port side, 30 minutes on the starboard side and 30 minutes as data recorder, followed by a break of at least 30 min when possible. Observers communicated with the data recorder using hand-held FRS radios.

Each observer scanned a 100° arc from the bow to 90° from the ship's heading, plus an additional 10° overlap across the bow of the ship. The observer scanned in one direction of the arc using regular binoculars or "big eyes", then reversed the scan direction and scanned the arc with bare eyes. Once an observer sighted a cetacean, the bearing and number of reticles from the horizon was recorded immediately to ensure an accurate time and position. For sightings made against land, the ship's position and heading were also recorded. For sightings in limited visibility, the actual estimated visibility to the reduced horizon was noted. When cetaceans were spotted within 500 m of the ship, the distance (in m) from the ship was estimated instead of using reticles. Sightings made after the animals had passed abeam of the ship (> 90°) were recorded but were not assigned sighting numbers and were not included in the on-effort sightings.

Species identification, number of animals, direction of travel and other data were added to the sighting record as they were determined (Appendix C and D). When species could not be determined, animals were classified according to the most likely category (e.g., "unknown large whale", "unknown dolphin/porpoise", etc.; see Appendix C and D).

2.4.5 Small boat operations

When circumstances and weather allowed, teams of 2-4 researchers were deployed in small boats (rigid-hull inflatable boats (RHIBs) or small aluminum skiffs) to investigate species of particular interest such as killer whales, humpback whales, blue

whales, fin whales and sperm whales. Photographs were taken for photo-identification of individual whales, and biopsy and prey samples were collected opportunistically.

2.5 DATA ANALYSIS

Data were summarized in MS Excel® (Microsoft Corp.) and ArcView® 9.3 (ESRI). Survey tracks were classified as on- or off-effort as per data recorded during the survey. On-effort survey tracks were plotted with ArcGIS® 9.3 (ESRI) in a UTM9N projection to calculate the distance of on-effort track for each survey. Sightings were also classified as on- or off-effort sightings, then on-effort sightings were summarized for each survey by total number of sightings by species and total number of individuals by species. The approximate distance to shore for each sighting was calculated within ArcGIS 9.3 by conducting a spatial join of uncorrected (position of ship when sighting occurred) sighting locations to the Canadian vector shoreline base map of British Columbia produced by the Canadian Hydrographic Service, Department of Fisheries and Oceans. The approximate depth for each sighting was calculated by sampling a coastal digital elevation model of British Columbia created by Natural Resources Canada produced by gridding 75 m X 75 m the 1:250,000 Canadian Hydrographic contours.

Figures were produced in ArcView 9.3, using BC Albers projection and the NAD 1983 datum. Scale for all figures are 1:5,450,000. Base maps include both the Canadian vector shoreline and coastal digital elevation model provided by the Department of Fisheries and Oceans and Natural Resources Canada, respectively. The coastal digital elevation model was classified into 5 depth zones in metres (0-100, 100-200, 200-500, 500-1,000, 1,000-2,500, 2,500-5,000, and > 5,000 m)

3.0 RESULTS AND DISCUSSION

3.1 SUMMARY OF SURVEYS

During 2002-2008, 21 dedicated cetacean surveys were conducted to collect sightings, photo-identification data and biological samples from cetaceans along the British Columbia coast. The dates of these surveys, the ship's used and the areas surveyed are provided in Table 1. Survey tracklines are depicted in Figure 1.

3.1.1 Summary of effort

Surveys ranged from 6 to 23 days in duration (mean = 12.5 days; median = 11.5 days) (Table 1). A total of 1,815 hr of observation effort was logged along 29,890 km of survey trackline (Tables 2, 3; Fig. 1). Surveys were conducted during all four seasons, although substantially more effort was applied during spring and summer (Table 3; Fig. 2).

Table 1. Summary of cetacean surveys conducted by the Cetacean Research Program, 2002-2008

Survey	Season	Start Date	End Date	Days	Vessel[a]	Area[b]
02-01	Spring	28-May-02	10-Jun-02	14	Vector / Gordon Reid	WCVI, HG
02-02	Summer	01-Aug-02	7-Aug-02	7	Curve of Time	WCVI, HG
03-01	Spring	22-May-03	7-Jun-03	18	Vector / Tanu	NC, HG
03-02	Summer	02-Aug-03	8-Aug-03	7	Curve of Time	NC, HG
03-06	Fall	18-Oct-03	28-Oct-03	11	JP Tully	NC
04-02	Spring	11-May-04	22-May-04	13	JP Tully	WCVI, HG
04-03	Summer	13-Aug-04	18-Aug-04	6	Curve of Time	WCVI, HG
04-04	Fall	13-Oct-04	21-Oct-04	8	JP Tully	NC, HG
05-01	Spring	09-May-05	22-May-05	12	Vector	NC, HG, VI
05-02	Summer	21-Aug-05	28-Aug-05	8	Curve of Time	WCVI, HG
06-01	Winter	03-Jan-06	26-Jan-06	23	JP Tully	NC, HG, WCVI
06-02	Spring	29-Apr-06	19-Jun-06	21	Tanu	NC, HG, WCVI
06-03	Summer	06-Aug-08	13-Aug-08	8	Curve of Time	VI, HG
06-04	Fall	21-Oct-06	29-Oct-06	8	JP Tully	NC, HG, VI
07-01	Winter	04-Feb-07	25-Feb-07	21	WE Ricker	NC, HG, AK
07-02	Spring	25-Apr-07	11-May-07	17	JP Tully	HG, AK, WCVI, VI
07-03	Summer	03-Aug-07	12-Aug-07	10	JP Tully	HG, WCVI
07-04	Fall	05-Oct-07	17-Oct-08	13	Gordon Reid	NC, HG, VI
08-01	Winter	04-Mar-08	17-Mar-08	14	JP Tully	NC, HG,AK, WCVI
08-02	Spring	05-May-08	19-May-08	15	JP Tully	HG, AK, VI, SG
08-03	Summer	13-Aug-08	22-Aug-08	10	Tanu	VI, HG

[a] Description of vessels provided in Appendix B. Abbreviations used for areas: NC = North Coast (BC mainland), HG = Haida Gwaii (Queen Charlotte Islands), VI = Vancouver Island, WCVI = West Coast Vancouver Island, AK = Southeastern Alaska (effort and sightings from AK portions of surveys are not included in this report).

Cetaceans were sighted on 3,535 occasions, and an estimated total of 17,483 cetaceans were counted (Table 2). Spring surveys were the most productive, logging an average of 13.72 sightings / 100 km and 2.41 sightings / effort hr (Table 3). However, more animals per effort distance and time were encountered during the summer surveys, due primarily to the large schools of Pacific white-sided dolphins (cumulative total of > 2,000 individuals) observed during survey 7-03 (Table 6). Sighting rates in winter were less then half those of spring and summer surveys.

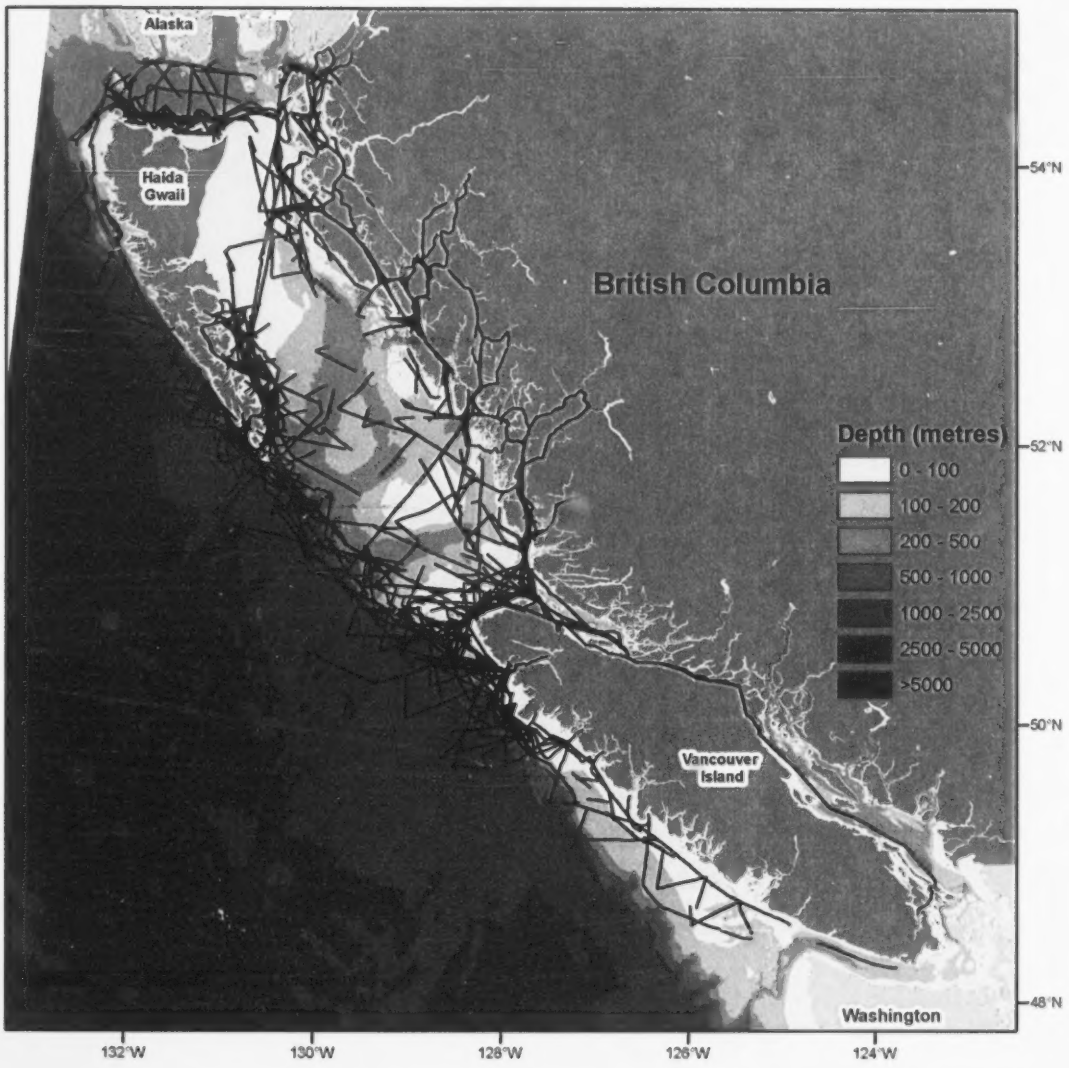

Figure 1. On-effort survey tracks for 21 cetacean surveys, 2002-2008. Total on-effort survey distance was 29,890 km with 1,815 effort hours.

3.1.2 Small boat effort

A considerable amount of small boat effort was undertaken during surveys in order to collect photo-identification data, biopsies and prey samples. Many thousands of photos were taken of killer whales, humpback whales, fin whales, sperm whales, grey whales and blue whales. These data have been utilized in various reports (e.g., Rambeau 2008; Calambokidis et al. 2009; Ford et al. 2009; Nichol et al. 2009) or are currently being analyzed. A total of 212 biopsy samples were obtained. Of these, 155 were from humpback whales, 30 from fin whales, 13 from killer whales, eight from

sperm whales, and six from blue whales. Prey samples collected in the vicinity of feeding humpback whales consisted of krill, copepods, and fish scales. Analysis of samples is ongoing.

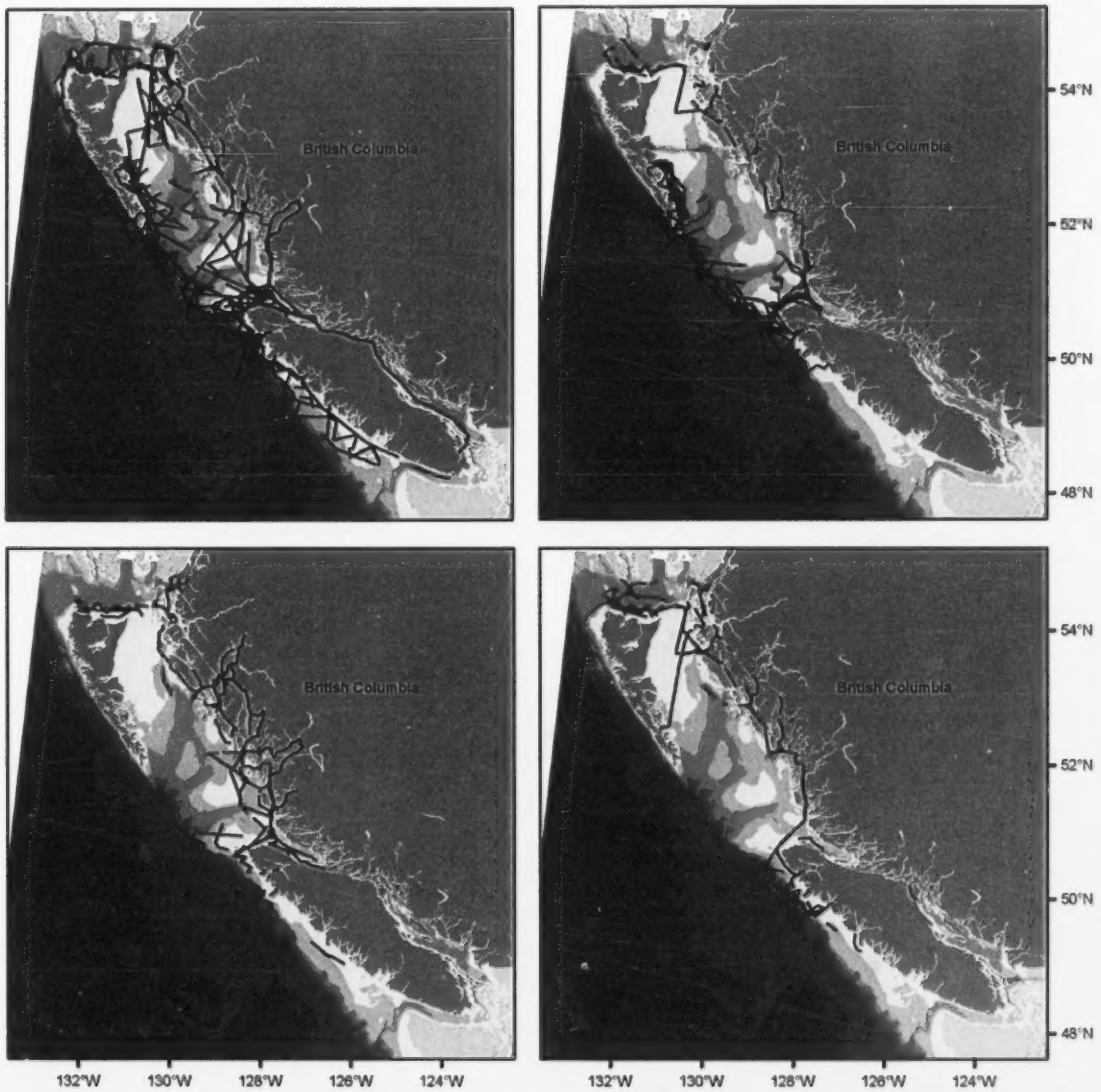

Figure 2. On-effort survey tracks during spring (15,702 km), summer (6,906 km), fall (4,035 km), and winter (3,247 km).

Table 2. Distance covered, hours of observation effort, and number of on-effort sightings by survey.

Survey	Effort		Sightings			Individuals		
	km	hours	Total	Per 100 km	Per hr	Total	Per 100 km	Per hr
02-01	1656	92.1	156	9.4	1.7	417	25.2	4.5
02-02	1,053	91.2	85	8.1	0.9	166	15.8	1.8
03-01	3,040	187.6	290	9.5	1.5	1,679	55.2	8.9
03-02	931	84.7	62	6.7	0.7	364	39.1	4.3
03-06	887	67.2	47	5.3	0.7	158	17.8	2.4
04-02	2,041	136.9	352	17.2	2.6	1,002	49.1	7.3
04-03	841	73.5	97	11.5	1.3	746	88.7	10.2
04-04	798	45.0	120	15.0	2.7	367	46.0	8.2
05-01	1,813	104.2	136	7.5	1.3	663	36.6	6.4
05-02	809	77.1	92	11.4	1.2	715	88.4	9.3
06-01	1,157	59.2	50	4.3	0.8	656	56.7	11.1
06-02	3,189	159.3	396	12.4	2.5	1,174	36.8	7.4
06-03	753	62.8	84	11.2	1.3	388	51.5	6.2
06-04	713	37.2	45	6.3	1.2	750	105.3	20.2
07-01	449	24.6	32	7.1	1.3	132	29.4	5.4
07-02	2,681	144.6	473	17.6	3.3	1,225	45.7	8.5
07-03	1,765	92.7	389	22.0	4.2	3,380	191.5	36.5
07-04	1,637	84.8	130	7.9	1.5	2,133	130.3	25.2
08-01	1,641	84.4	63	3.8	0.7	340	20.7	4.0
08-02	1,283	68.5	352	27.4	5.1	673	52.5	9.8
08-03	754	37.5	84	11.1	2.2	355	47.1	9.5
Total	29,890	1,815	3,535			17,483		

Table 3. Distance covered, hours of observation effort, and number of on-effort sightings (and percent of total in parentheses) by season.

Season	Effort		Sightings			Individuals		
	Total distance (km)	Total hours	Total	per 100 km	per hr	Total	per 100 km	per hr
Spring (2002-2008)	15,702 (52%)	893.2 (49%)	2,155 (61%)	13.72	2.41	6,833 (39%)	43.52	7.65
Summer (2002-2008)	6,906 (23%)	519.4 (28%)	893 (25%)	12.93	1.72	6,114 (35%)	88.53	11.77
Fall (2003-2007)	4,035 (13%)	234.2 (12%)	342 (10%)	8.48	1. 46	3,408 (19%)	84.46	14.55
Winter (2006-2008)	3,247 (10%)	168.2 (9%)	145 (4%)	4.47	0.86	1,128 (6%)	34.75	6.71
Overall	29,890	1815.0	3,535	11.83	1.95	17,483	58.49	9.63

3.2 CETACEAN SIGHTINGS

Of the 3,535 cetacean sightings, 673 could not be identified to species, usually because they were too distant from the ship when in passing survey mode (Table 4). A total of 2,862 sightings, representing an estimated 16,529 individuals were identified to species. Fifteen species of cetaceans were sighted. The species most frequently observed (> 100 sightings each) were humpback whale, Dall's porpoise (*Phocoenoides dalli*), fin whale and Pacific white-sided dolphin (*Lagenorhynchus obliquidens*) (Table 4, 5, 6). Less frequently sighted species (10-100 sightings) included grey whale (*Eschrichtius robustus*), killer whale (*Orcinus orca*), sperm whale (*Physeter macrocephalus*), common minke whale (*Balaenoptera acutorostrata*), and harbour porpoise (*Phocoena phocoena*). Rarely seen species (< 10 sightings) included blue whale, Baird's beaked whale (*Berardius bairdii*), Cuvier's beaked whale (*Ziphius cavirostris*), false killer whale (*Pseudorca crassidens*), northern right whale dolphin (*Lissodelphis borealis*), and Risso's dolphin (*Grampus griseus*) (Tables 4, 5, 6).

Ten cetacean species known to occur in BC waters were not seen during the surveys. These are North Pacific right whale (*Eubalaena japonica*), sei whale (*Balaenoptera borealis*), Stejneger's beaked whale (*Mesoplodon stejnegeri*), Hubbs' beaked whale (*Mesoplodon carlhubbsi*), short-beaked common dolphin (*Delphinus delphis*), long-beaked common dolphin (*Delphinus capensis*), striped dolphin (*Stenella coeruleoalba*) dwarf sperm whale (*Kogia sima*), pygmy sperm whale (*Kogia breviceps*) and short-finned pilot whale (*Globicephala macrorhynchus*). These species are rarely seen in BC waters due to depletion by past commercial whaling (right whale, sei whale), being naturally uncommon and inconspicuous (the beaked whales), or vagrant and/or accidental in the area. In the following sections, a brief overview of the status of each of the 15 sighted species is provided along with a summary of sightings made during the surveys.

3.2.1 Blue whale

As in most of the world's oceans, blue whales in the northeastern Pacific were severely depleted by whaling during the first half of the 20th century. Almost 1400 blue whales were taken in BC waters, mostly prior to 1915, from shore-based whaling stations on the west coast of Vancouver Island and Haida Gwaii (Gregr et al. 2000). Blue whales were taken mostly in deep shelf-break or offshore waters (Gregr and Trites 2001). Photo-identification studies of blue whales found off California during summer have yielded a recent abundance estimate of about 2,800 individuals (Calambokidis et al. 2007). This population is believed to migrate to waters off Baja California and the Costa Rica Dome during winter. Like other high latitude areas, BC waters are feeding grounds for blue whales. Primary prey is krill, or euphausiid crustaceans. The blue whale is listed as Endangered in Pacific Canadian waters under SARA.

Blue whales were seen on six occasions (Fig. 3). During survey 02-1 (June), one blue whale was seen near the continental shelf break about half way between Vancouver Island and Haida Gwaii. During survey 05-2 (August), two single blue

whales were sighted on the same day, in about 1000 m deep water west of Kunghit Island, Haida Gwaii, along the shelf break approximately 10-11 km offshore. During survey 07-03, three single blue whales were encountered over a two day period in waters 2200-2500 m in depth, approximately 40 to 60 km southwest of Cape St. James, Haida Gwaii. The locations of these sightings are in an area where large numbers of blue whales were killed during the whaling era (Gregr and Trites 2001). Photo-identifications collected during these surveys have been matched to blue whales photographed off California, indicating that blue whales in BC waters are part of that population (Calambokidis et al. 2009).

Table 4. Summary of on-effort sightings for all surveys combined for both identified and unidentified cetacean species. Shown are number of sightings and individuals, proportion of total sightings and individuals, and number of sightings and individuals per 100 km of survey track.

Species	Sightings			Individuals		
	n	%	per 100 km	n	%	per 100 km
Blue whale	6	0.2	0.02	6	0.0	0.02
Fin whale	257	9.0	0.86	482	2.9	1.61
Common minke whale	18	0.6	0.06	21	0.1	0.07
Humpback whale	1,700	59.4	5.69	3,162	19.1	10.58
Grey whale	23	0.8	0.08	44	0.3	0.15
Sperm whale	37	1.3	0.12	42	0.3	0.14
Baird's beaked whale	3	0.1	0.01	16	0.1	0.05
Cuvier's beaked whale	3	0.1	0.01	4	0.0	0.01
False killer whale	1	0.0	0.00	1	0.0	0.00
Killer whale	69	2.4	0.23	578	3.5	1.93
Northern right whale dolphin	5	0.2	0.02	870	5.3	2.91
Pacific white-sided dolphin	183	6.4	0.61	8,991	54.4	30.08
Risso's dolphin	2	0.1	0.01	11	0.1	0.04
Dall's porpoise	482	16.8	1.61	2,098	12.7	7.02
Harbour porpoise	73	2.6	0.24	203	1.2	0.68
Total - identified species	**2,862**	**100**	**9.58**	**16,529**	**100**	**55.30**
Unidentified large cetacean	462	68.6	1.55	648	68.2	2.17
Unidentified small cetacean	46	6.8	0.15	112	11.8	0.37
Unidentified cetacean	165	24.5	0.55	190	20.0	0.64
Total – unidentified	**673**	**100**	**2.25**	**950**	**100**	**3.18**
GRAND TOTAL	**3,535**		**11.83**	**17,479**		**58.49**

Table 5. Number of cetacean sightings identified to species, by survey. Dates and other details for each survey are provided in Table 1.

Species[a]	Survey										
	02-01	02-02	03-01	03-02	03-06	04-02	04-03	04-04	05-01	05-02	06-01
BW	1	0	0	0	0	0	0	0	0	2	0
FW	21	2	7	4	0	37	13	0	2	15	1
CMW	0	0	2	0	0	2	0	0	0	0	1
HW	69	34	144	28	37	176	49	80	54	56	4
GW	0	2	0	1	0	4	1	0	0	0	6
SPW	6	2	2	5	0	8	3	0	0	0	0
BBW	0	0	1	0	0	0	0	0	0	0	0
CBW	0	0	0	2	0	0	0	0	0	1	0
FKW	0	0	0	0	0	0	1	0	0	0	0
KW	2	1	12	2	4	10	1	0	6	1	1
NRWD	0	0	0	0	0	0	1	0	0	1	0
PWSD	4	2	19	1	1	11	6	1	5	1	9
RD	0	0	0	0	0	0	0	0	0	0	0
DP	28	16	70	11	3	42	4	18	39	2	21
HP	4	4	2	1	0	14	7	2	5	4	1
TOTAL	135	63	259	55	45	304	86	101	111	83	44

	06-02	06-03	06-04	07-01	07-02	07-03	07-04	08-01	08-02	08-03	TOTAL
BW	0	0	0	0	0	3	0	0	0	0	6
FW	45	4	1	2	38	25	4	5	24	7	257
CMW	9	0	0	0	2	0	0	0	1	1	18
HW	147	57	27	2	242	196	60	7	221	10	1,700
GW	1	0	1	0	1	0	0	3	2	1	23
SPW	2	2	0	0	2	4	0	0	0	1	37
BBW	0	0	0	0	1	0	0	0	0	1	3
CBW	0	0	0	0	0	0	0	0	0	0	3
FKW	0	0	0	0	0	0	0	0	0	0	1
KW	8	4	1	0	7	4	1	1	0	3	69
NRWD	0	0	0	0	0	3	0	0	0	0	5
PWSD	14	1	3	6	19	21	16	24	16	3	183
RD	0	1	0	0	1	0	0	0	0	0	2
DP	47	4	5	19	24	51	8	10	25	35	482
HP	6	1	0	1	3	0	1	0	16	1	73
TOTAL	279	74	38	30	340	307	90	50	305	63	2,862

[a] Species Abbreviations: BW=blue whale, FW=fin whale, CMW=common minke whale, HW=humpback whale, GW=grey whale, SPW=sperm whale, BBW=Baird's beaked whale, CBW=Cuvier's beaked whale, FKW=false killer whale, KW=killer whale, NRWD=northern right whale dolphin, PWSD=Pacific white sided dolphin, RD=Risso's dolphin, DP=Dall's porpoise, HP=harbour porpoise.

Table 6. Number of individuals identified to species, by survey. Dates and other details for each survey are provided in Table 1.

Species[a]	Survey										
	02-01	02-02	03-01	03-02	03-06	04-02	04-03	04-04	05-01	05-02	06-01
BW	1	0	0	0	0	0	0	0	0	2	0
FW	63	4	15	10	0	70	19	0	2	24	5
CMW	0	0	3	0	0	2	0	0	0	0	1
HW	97	53	270	61	68	324	74	228	86	96	18
GW	0	3	0	2	0	9	1	0	0	0	12
SPW	7	2	2	8	0	9	3	0	0	0	0
BBW	0	0	7	0	0	0	0	0	0	0	0
CBW	0	0	0	3	0	0	0	0	0	1	0
FKW	0	0	0	0	0	0	1	0	0	0	0
KW	5	3	98	13	52	84	8	0	40	10	15
NRWD	0	0	0	0	0	0	300	0	0	300	0
PWSD	113	7	926	200	10	205	272	1	338	250	454
RD	0	0	0	0	0	0	0	0	0	0	0
DP	87	62	314	55	26	177	15	103	156	9	143
HP	6	7	2	5	0	57	17	5	8	6	2
TOTAL	379	141	1,637	357	156	937	710	337	630	698	650

	06-02	06-03	06-04	07-01	07-02	07-03	07-04	08-01	08-02	08-03	TOTAL
BW	0	0	0	0	0	3	0	0	0	0	6
FW	93	5	1	6	76	34	4	7	36	8	482
CMW	10	0	0	0	2	0	0	0	2	1	21
HW	328	80	39	2	368	408	186	7	356	13	3,162
GW	1	0	1	0	1	0	0	9	3	2	44
SPW	2	2	0	0	2	4	0	0	0	1	42
BBW	0	0	0	0	4	0	0	0	0	5	16
CBW	0	0	0	0	0	0	0	0	0	0	4
FKW	0	0	0	0	0	0	0	0	0	0	1
KW	69	33	21	0	32	42	6	2	0	45	578
NRWD	0	0	0	0	0	270	0	0	0	0	870
PWSD	271	200	654	38	466	2,310	1,853	248	72	103	8,991
RD	0	4	0	0	7	0	0	0	0	0	11
DP	203	49	26	81	103	190	26	49	76	148	2,098
HP	9	1	0	3	11	0	4	0	58	2	203
TOTAL	986	374	742	130	1,072	3,261	2,079	322	603	328	16,529

[a] Species Abbreviations: BW=blue whale, FW=fin whale, CMW=common minke whale, HW=humpback whale, GW=grey whale, SPW=sperm whale, BBW=Baird's beaked whale, CBW=Cuvier's beaked whale, FKW=false killer whale, KW=killer whale, NRWD=northern right whale dolphin, PWSD=Pacific white sided dolphin, RD=Risso's dolphin, DP=Dall's porpoise, HP=harbour porpoise.

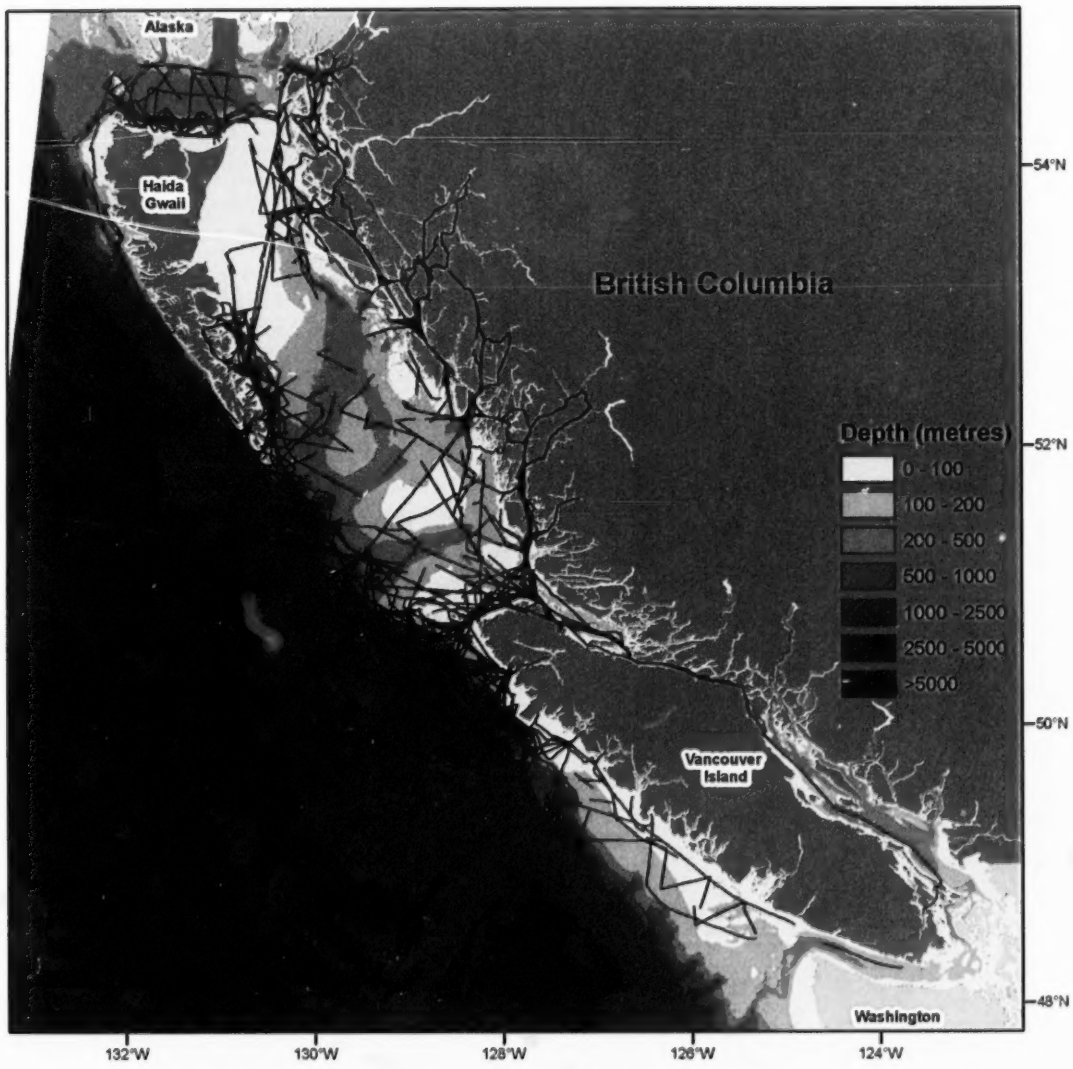

Figure 3. Sightings of blue whales for all surveys (n = 6).

3.2.2 Fin whale

The fin whale is a cosmopolitan species found from the polar regions to the equator. It was depleted during the commercial whaling era, though not as severely as the blue whale. An estimated 40,000 to 45,000 fin whales existed in the North Pacific prior to whaling in the 20th century, and perhaps 13,000-19,000 remained when whaling ended in the late 1960s. Over 7,600 fin whales were taken in BC waters between 1908 and 1967. Most were captured in deep water beyond the shelf break, but substantial numbers were also taken in Dixon Entrance and eastern Hecate Strait (Greg and Trites 2001). Fin whales in BC waters feed predominantly on euphausiids and occasionally on copepods and small schooling fish (Flinn et al. 2002). The fin whale is listed as Threatened in Pacific Canadian waters under SARA.

Fin whales were sighted on 257 occasions, representing 9% of all identified sightings and the third most often sighted species (Table 4). Fin whales were sighted at a rate of 0.86 sightings / 100 km and were seen on 19 of the 21 surveys. The two surveys on which this species was not sighted (Table 5) were in the fall and were focused mostly in the inlets and channels of the northern mainland coast. A total of 482 fin whales were sighted (1.61 animals / 100 km) and sightings typically consisted of solitary animals or pairs (group size range = 1-7, mode = 1, median = 1) (Table 7). Fin whales were sighted in all seasons including winter, which is consistent with observations noted by Mizroch et al. (2009) of a rather diffuse migratory pattern and year-round occurrence in high latitudes in the N Pacific.

Fin whales were seen mostly over the continental shelf break along the west coast of Haida Gwaii, and south along the continental shelf edge between Cape St James and Cape Scott (Fig. 4). There were also numerous sightings off Juan Perez Sound in Hecate Strait and a few sightings in Dixon Entrance and off northwestern Vancouver Island (Fig. 4). Approximately 37% of sightings were within 20 km of shore, and 82% of sightings were within 50 km. The furthest distance from shore a fin whale was observed was over 115 km, which was the maximum offshore extent of our survey effort. On average, fin whales were sighted in 725 m of depth, with the maximum depth over 2,800 m.

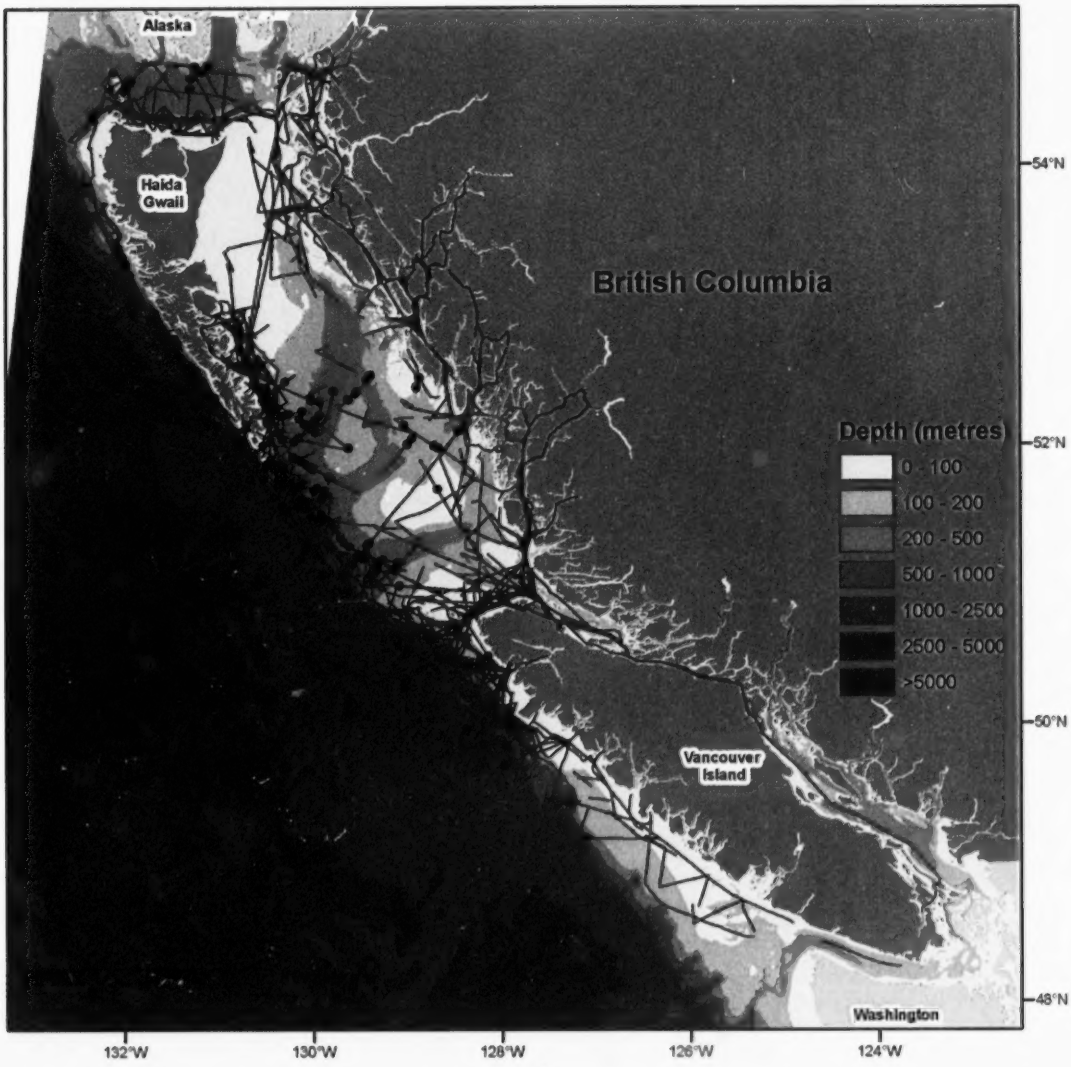

Figure 4. Sightings of fin whales for all surveys (n = 257).

Table 7. Summary of fin whale sightings. Dates and other details for each survey are provided in Table 1.

Survey	Sightings			Individuals			Group size		
	n	Per 100 km	Per effort hr	n	Per 100 km	Per effort hr	Range	Mean	Mode
02-01	21	1.27	0.23	63	3.80	0.68	1-7	3	2
02-02	2	0.19	0.02	4	0.38	0.04	2	2.00	2
03-01	7	0.23	0.04	15	0.49	0.08	1-5	2.14	1
03-02	4	0.43	0.05	10	1.07	0.12	1-5	2.50	2
03-06	0	0.00	0.00	0	0 00	0.00	-	-	-
04-02	37	1.81	0.27	70	3.43	0.51	1-5	1.89	1
04-03	13	1.55	0.18	19	2.26	0.26	1-3	1.46	1
04-04	0	0.00	0.00	0	0.00	0.00	-	-	-
05-01	2	0.19	0.02	2	0.11	0.02	1	1.00	1
05-02	15	1.85	0.19	24	2.97	0.31	1-5	1.60	1
06-01	1	0.09	0.02	5	0.43	0.08	5	5.00	-
06-02	45	1.41	0.28	93	2.92	0.58	1-7	2.07	1
06-03	4	0.53	0.06	5	0.66	0.08	1-2	1.25	1
06-04	1	0.14	0.03	1	0.14	0.03	1	1.00	-
07-01	2	0.45	0.08	6	1.34	0.24	2-4	3.00	-
07-02	38	1.42	0.26	76	2.83	0.53	1-6	2.00	1
07-03	25	1.42	0.27	34	1.93	0.37	1-4	1.36	1
07-04	4	0.24	0.05	4	0.24	0.05	1	1.00	1
08-01	5	0.30	0.06	7	0.43	0.08	1-2	1.40	1
08-02	24	1.87	0.35	36	2.81	0.53	1-3	1.50	1
08-03	7	0.93	0.19	8	1.06	0.21	1-2	1.14	1
Overall	257	0.86	0.14	482	1.61	0.27	1-7	1.88	1

3.2.3 Common minke whale

Minke whales are found in both the northern and southern hemispheres, with different species and/or subspecies occurring in different ocean areas. In the North Pacific, a single species, the common minke whale, is widespread from the Bering Sea to equatorial waters. Although they can be found in offshore waters, they tend to occur primarily in shallow, coastal areas. In the northeastern Pacific, common minke whales appear generally to move to low latitudes in winter for breeding, but they can be found in waters of British Columbia and Washington State throughout the year (Dorsey et al. 1990). Minke whales were rarely taken by commercial whalers off Canada's west coast due to their small size (Pike and MacAskie 1969). Minke whales feed mostly on small schooling fish such as herring and sandlance, though euphausiids and other crustaceans are also consumed (Dorsey et al. 1990; COSEWIC 2006). The species is

listed as Not at Risk by COSEWIC, although it is not particularly abundant in BC waters (COSEWIC 2006).

Common minke whales were sighted on 18 occasions, all during either spring, summer, or fall surveys (Fig. 5). Half of the sightings were within 20 km of shore and the greatest distance offshore was approximately 60 km. Minke whales were sighted primarily in shallow waters (mean depth approximately 80 m), although two sightings were in waters over 300 m in depth. Most sightings were in shallow areas of Hecate Strait and Goose Bank. Group size was 1-2 animals (mode = 1).

3.2.4 Humpback whale

The humpback whale is found in all the world's oceans. Like most baleen whales, the humpback is strongly migratory, moving seasonally between low latitude breeding areas and high latitude feeding areas. All populations of humpback whales were severely reduced by 19th and 20th century whaling but many are showing strong recovery. Less than 1,500 humpbacks are thought to have existed in the North Pacific when whaling ended in the mid 1960s, but the recent SPLASH study estimated an abundance of about 18,000 in 2005 (Calambokidis et al. 2008). Photo-identification studies have determined that humpback whale abundance in BC waters has been growing at about 4% annually in recent years, with an abundance of approximately 2100 whales in 2006 (Ford et al. 2009). Humpback whales inhabit both nearshore and offshore areas, and feed on euphausiids and other crustaceans as well as schooling fish, including herring, sandlance and sardine in BC waters (Ford et al. 2009). The species is currently listed as Threatened in Pacific Canadian waters under SARA.

Humpback whales were the most frequently sighted species, with 1,700 sightings (59% of total identified sightings) and 3,162 individuals (19% of total) recorded (Table 4). Humpback whales were sighted on all surveys at an overall rate of 5.69 sightings per 100 km (10.58 individuals / 100 km). The highest densities of humpback whales were recorded on surveys 08-02 (spring), 07-03 (summer) and 4-04 (fall), with densities of 17.23, 11.11 and 10.03 sightings / 100 km respectively (Table 8). Humpbacks were also sighted during winter surveys, particularly in Chatham Sound and off northern Haida Gwaii.

Humpback whales were typically sighted alone or in pairs, although some larger groups were recorded (group size range = 1-35; mean = 1.86, mode = 1 (Table 8). Only 119 sightings (7%) consisted of greater then 3 individuals, and only 23 sightings (1%) had greater then 10 animals.

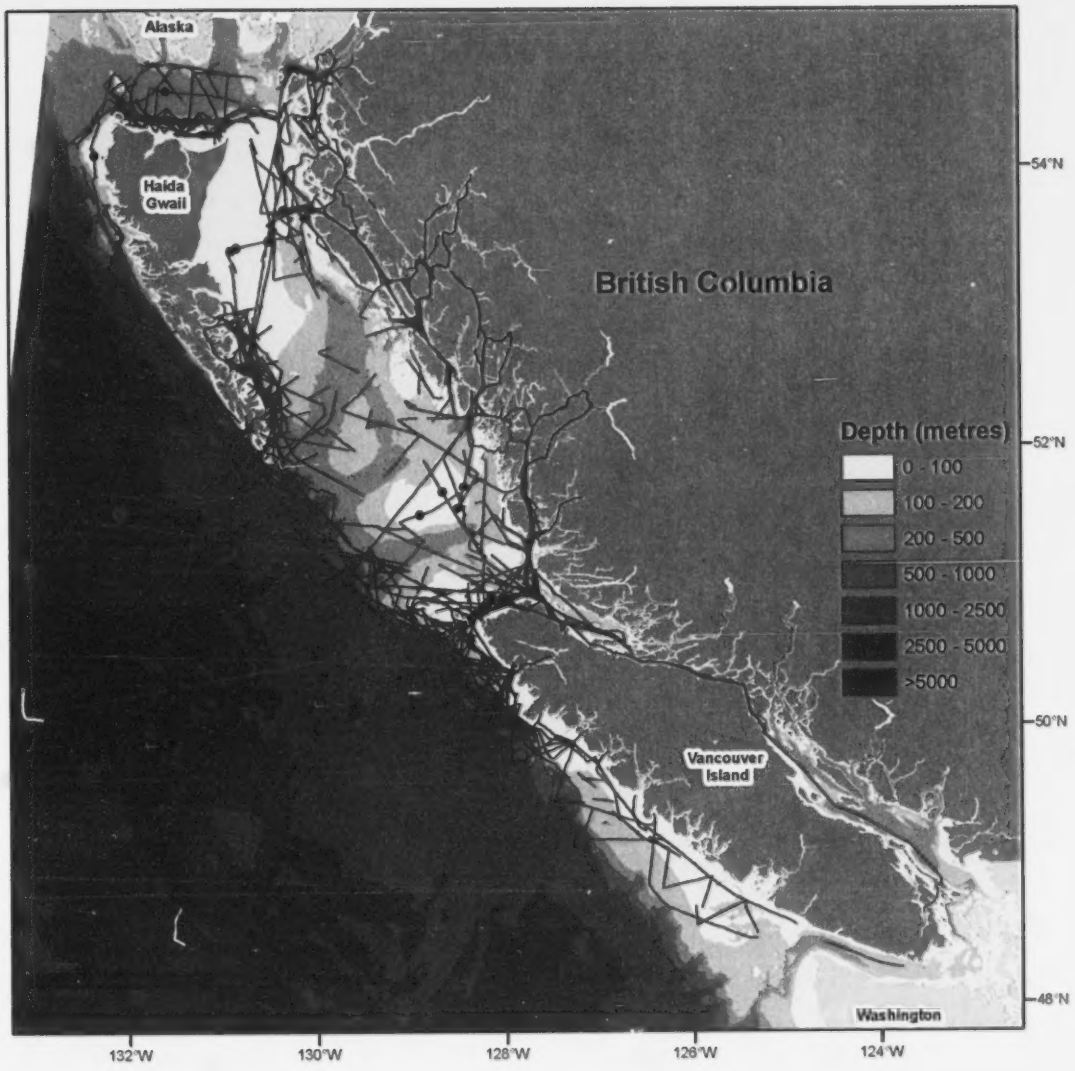

Figure 5. Sightings of common minke whales for all surveys (n = 18).

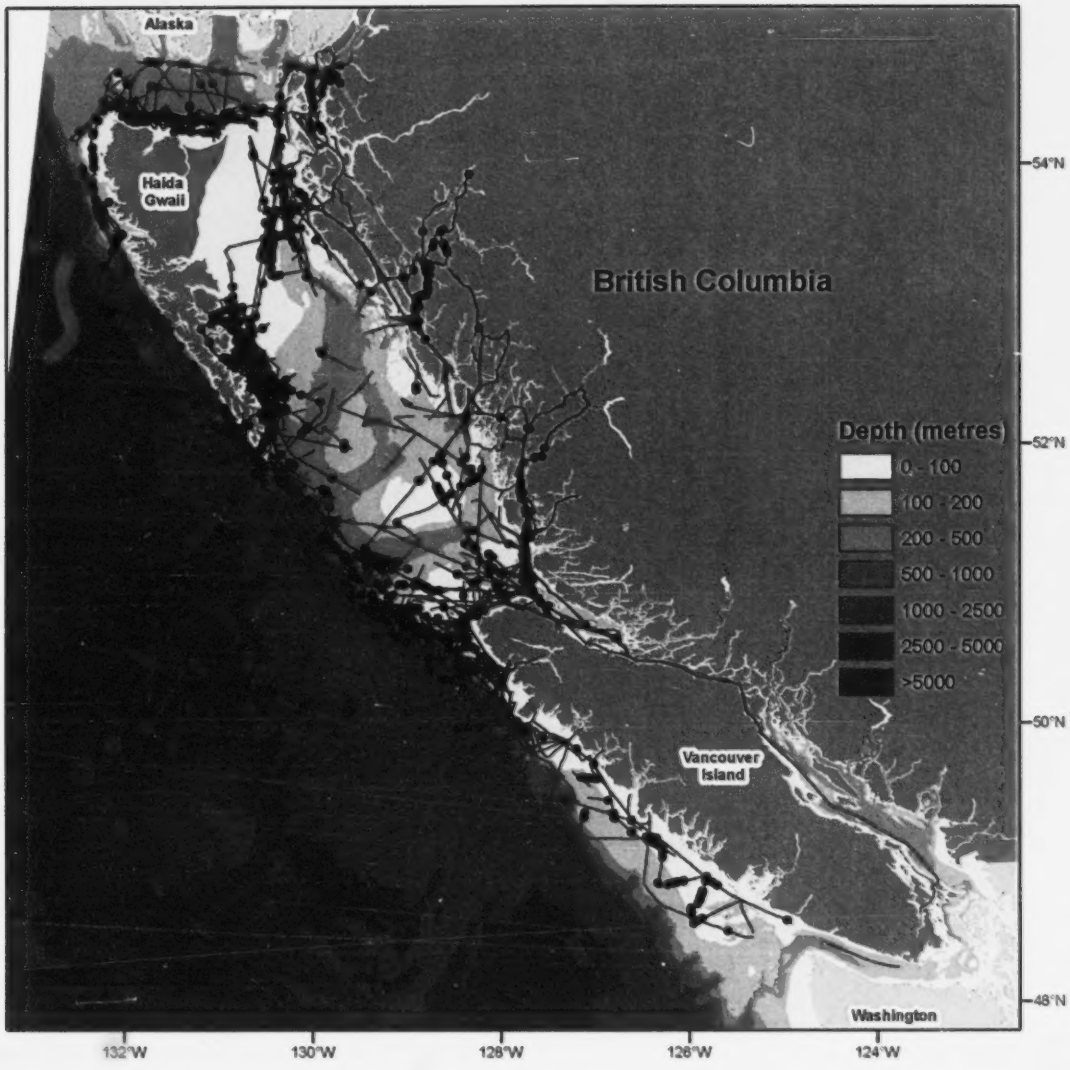

Figure 6. Sightings of humpback whales for all surveys (n = 1,700).

Humpback whales were widespread through most areas surveyed (Fig. 6). Areas where animals were consistently concentrated include the waters around Haida Gwaii (particularly in and near Juan Perez Sound, Laskeek Bank, Cape St. James and the west and north coasts of Graham Island, including Langara Island), as well as along the continental shelf break between Cape St. James and Cape Scott (Fig. 6). Humpback whales were also frequently seen in Chatham Sound, eastern Hecate Strait and around Gil Island on the northern mainland coast. Sightings were also recorded off southwest Vancouver Island, in Johnstone Strait, in northern Hecate Strait and in several mainland inlets. Most humpback whales were encountered in waters less then 500 m deep (85%), except along the continental shelf break where whales were found in waters up to 2,800 m deep. Approximately 77% of humpback whale sightings were within 20 km of shore (Fig. 6).

Table 8. Summary of humpback whale sightings. Dates and other details for each survey are provided in Table 1.

Survey	Sightings			Individuals			Group size		
	n	Per 100 km	Per effort hr	n	Per 100 km	Per effort hr	Range	Mean	Mode
02-01	69	4.17	0.75	97	5.86	1.05	1-6	1.41	1
02-02	34	3.23	0.37	53	5.03	0.58	1-3	1.56	2
03-01	144	4.74	0.77	270	8.88	1.44	1-20	1.88	1
03-02	28	3.01	0.33	61	6.55	0.72	1-10	2.18	1
03-06	37	4.17	0.55	68	7.66	1.01	1-8	1.84	1
04-02	176	8.62	1.29	324	15.88	2.37	1-28	1.84	1
04-03	49	5.83	0.67	74	8.80	1.01	1-4	1.51	1
04-04	80	10.03	1.78	228	28.58	5.07	1-15	2.85	1
05-01	54	2.98	0.52	86	4.74	0.83	1-8	1.59	1
05-02	56	6.92	0.73	96	11.87	1.24	1-6	1.71	1
06-01	4	0.35	0.07	18	1.56	0.30	1-13	4.50	2
06-02	147	4.61	0.92	328	10.28	2.06	1-20	2.23	1
06-03	57	7.57	0.91	80	10.62	1.27	1-5	1.40	1
06-04	27	3.79	0.73	39	5.47	1.05	1-4	1.44	1
07-01	2	0.45	0.08	2	0.45	0.08	1	1.00	1
07-02	242	9.03	1.67	368	13.73	2.54	1-5	1.52	1
07-03	196	11.11	2.11	408	23.12	4.40	1-35	2.08	1
07-04	60	3.66	0.71	186	11.36	2.19	1-35	3.10	1
08-01	7	0.43	0.08	7	0.43	0.08	1	1.00	1
08-02	221	17.23	3.23	356	27.75	5.20	1-14	1.61	1
08-03	10	1.33	0.27	13	3.66	0.35	1-2	1.30	1
Overall	1,700	5.69	0.94	3,162	10.58	1.74	1-35	1.86	1

3.2.5 Grey whale

The grey whale is found only in the North Pacific, with separate populations inhabiting the eastern and western margins of the ocean basin. The eastern population migrates seasonally in nearshore waters between breeding grounds off Baja California and summer feeding grounds in the Bering and Chukchi Seas. This population was greatly reduced by 19th century whaling but has since recovered. Its abundance was estimated at about 18,000 animals in 2002 (COSEWIC 2004). Grey whales feed in shallow waters on benthic or epibenthic crustaceans and molluscs. Although most grey whales spend the summer feeding in high latitude waters, several hundred whales, known as the Pacific Coast Feeding Aggregation, feed in nearshore locations scattered along the coast from northern California to SE Alaska (Calambokidis et al. 2002). The species is listed as Special Concern under SARA.

Since most survey effort took place in waters > 5 km from shore and outside the migration periods of March/April and late December/January, relatively few grey whales were sighted during these surveys. A total of 23 sightings were made, most along the northwest and north coasts of Vancouver Island and in northern Hecate Strait (Fig. 7). About 70% of sightings were within 10 km of shore and in water less than 100 m deep. The furthest sighting offshore was approximately 26 km from land. Group sizes ranged from 1 to 5 animals (mode = 2).

3.2.6 Sperm whale

The sperm whale is a deep-diving toothed whale found in oceanic waters throughout the world's oceans. The species is widespread in the North Pacific, although the majority appears to spend the winter south of 40°N latitude (Carretta et al. 2009). Females and young tend to stay in tropical to temperate waters throughout the year while mature males migrate to higher latitudes in summer to feed. Whaling records indicate that females seldom range further north than about 51°N and tend to be found further offshore than males (Gregr et al. 2000). Over 6,000 sperm whales were killed in BC waters during the whaling era, mostly during 1930-1967 (Gregr et al. 2000). The sperm whale is considered by COSEWIC to be Not at Risk in Pacific Canadian waters.

A total of 37 sightings of sperm whales were recorded, mostly involving solitary individuals or pairs (mode = 1) (Table 4, Fig. 8). No larger groups typical of females and young were observed. Sperm whales were only encountered during spring and summer surveys and all were associated with the continental shelf break in waters ranging from 200-2,400 m (mean = 1,033 m; median = 862 m) along the west coast of Haida Gwaii and off the northwest coast of Vancouver Island (Fig. 8). Approximately 80% of sightings were greater than 10 km from shore.

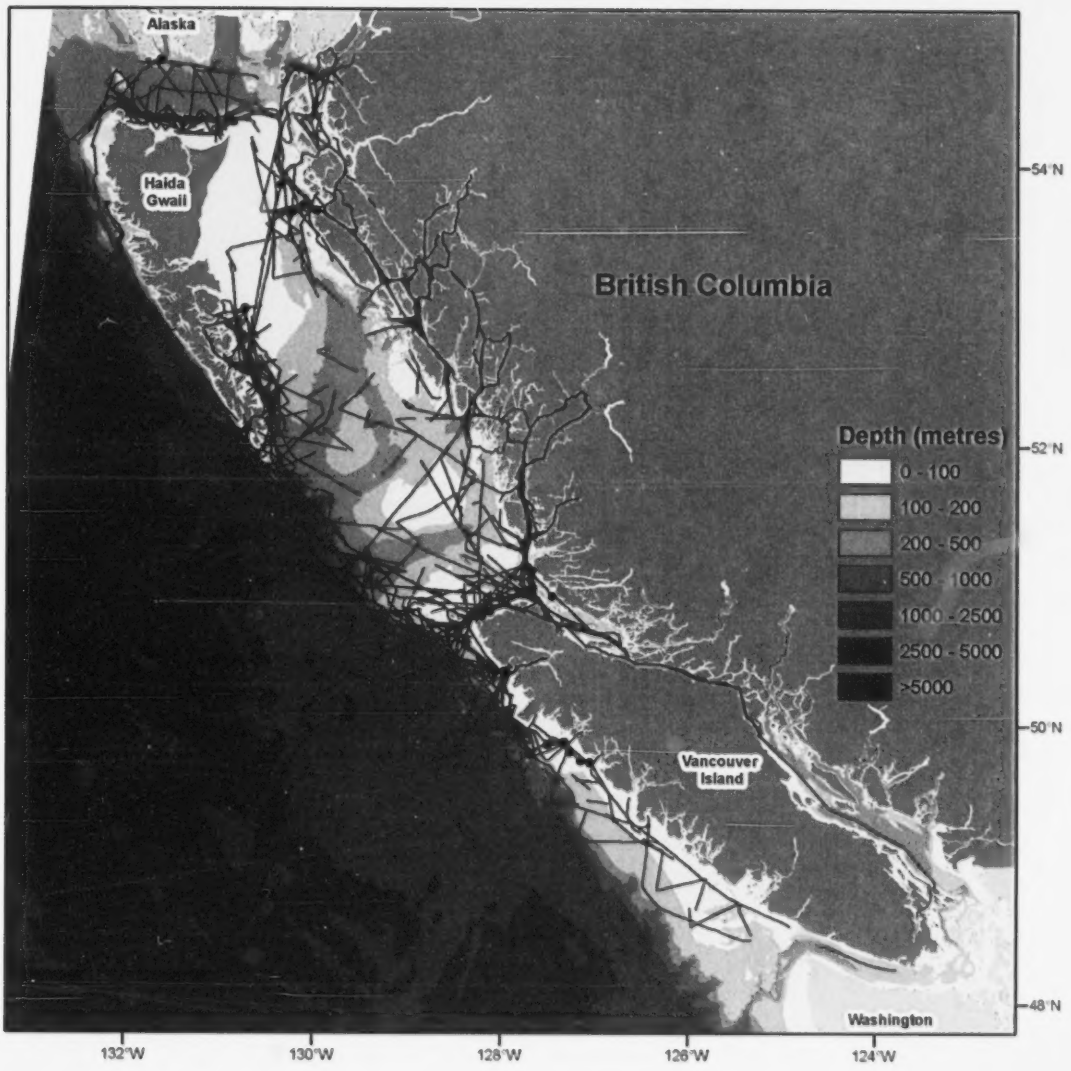

Figure 7. Sightings of grey whales for all surveys (n = 23).

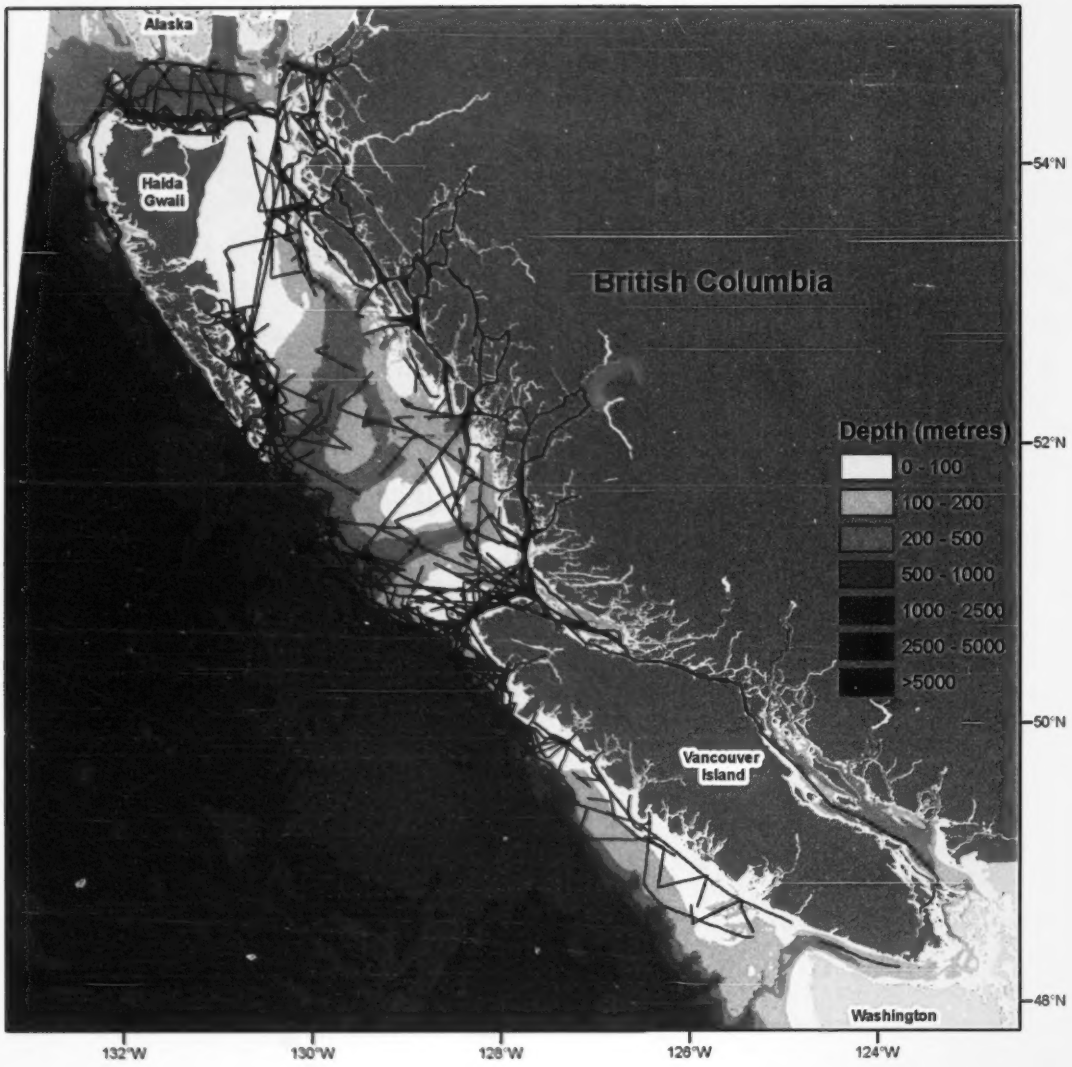

Figure 8. Sightings of sperm whales for all surveys (n = 37).

3.2.7 Baird's beaked whale

Baird's beaked whale is a large toothed whale that inhabits cool, deep waters of the North Pacific north of 30°N. Unlike most beaked whale species, it tends to travel in groups of several to 20 or more individuals, and thus is relatively conspicuous at sea. Baird's beaked whale was of minor importance to commercial whalers in BC, and only 35 animals were killed off the BC coast during 1950-1966 (Reeves and Mitchell 1993). Whalers off the west coast of Vancouver Island apparently sighted it frequently during the whaling season of May through September, with most seen and taken in August (Pike and MacAskie 1969). The species is considered by COSEWIC to be Not at Risk in Pacific Canadian waters.

Baird's beaked whales were seen on three occasions on three different surveys, all during May (Fig. 9). A group of seven Baird's beaked whales was sighted during survey 03-1 (May), along the continental shelf break (depth approximately 1000 m) south of Cape St James about 23 km from shore. A group of four animals was observed on the 07-02 survey (May) within 5 km of Cape St. James in depths of approximately 300 m. A group of 5 animals was seen on the 08-02 survey about 100 km south of Cape St. James in 2,000 m depth.

3.2.8 Cuvier's beaked whale

Cuvier's beaked whale is a medium-sized toothed whale that is widespread in tropical to temperate waters throughout the world's oceans. Like most beaked whales, the species is inconspicuous at sea and is mostly known from stranding records. Globally, strandings of Cuvier's beaked whale are the most numerous of the beaked whales, suggesting that it may also be the most abundant. In BC, Cuvier's beaked whale is known from 18 stranding records and four sightings, mostly around Haida Gwaii and the west coast of Vancouver Island (Ford et al. 1994; Willis and Baird 1998). The species is considered by COSEWIC to be Not at Risk in Pacific Canadian waters.

Cuvier's beaked whales were sighted on two surveys. A single animal and a pair were seen during survey 03-2, near Quatsino Sound, Vancouver Island. A single animal was also seen during survey 05-2, near Skincuttle Inlet, Haida Gwaii (Fig. 9). All sightings of Cuvier's beaked whales occurred in August, within 5-15 km of shore and in waters 75-200 m deep.

3.2.9 Killer whale

The killer whale is the most cosmopolitan cetacean, occurring in tropical to polar regions in all the world's oceans and most seas. It is the apex marine predator, feeding on a wide diversity of prey types. Different populations are often ecologically specialized and have a narrow dietary range (Ford 2009). Killer whales are particularly well known and studied in BC waters. Three distinct lineages of killer whales inhabit these waters – 'residents', which feed primarily on salmon, 'transients', which feed almost exclusively on marine mammals, and 'offshores', which are piscivorous and may

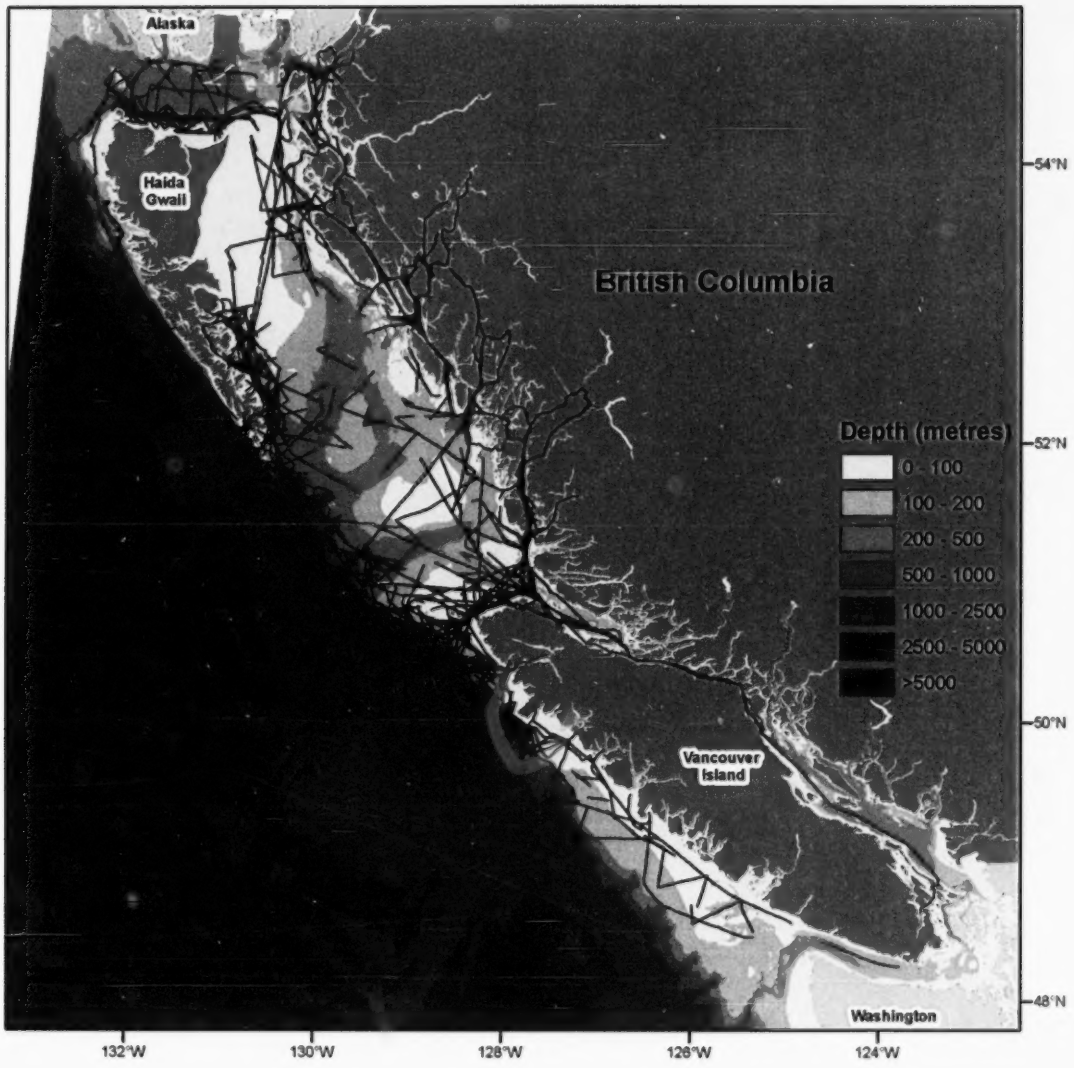

Figure 9. Sightings of Baird's beaked whales (black dots, n = 3) and Cuvier's beaked whales (red dots, n = 3) for all surveys.

specialize on sharks (Ford et al. 1998, 2009, in press). Resident killer whales form two distinct populations in BC waters – 'southern residents' and 'northern residents', which are listed as Endangered and Threatened, respectively, under the SARA. Transient killer whales are listed as Threatened and offshore killer whales as Special Concern, with uplisting to Threatened pending.

A total of 69 groups of killer whales were encountered (Fig. 10; Table 9); overall occurrence was 0.23 encounters per 100 km. Of these groups, 36 were transients, 20 were northern residents, and one was a group of southern residents. The remaining 13 groups could not be identified due to poor sighting conditions and/or the inability to launch a small boat in order to obtain photographs for identification purposes. No killer whales of the offshore lineage were encountered. Most of the killer whale groups were encountered during spring surveys (26 of 36 transient sightings, 11 of 20 northern resident sightings and the single southern resident sighting), although this is likely related to the greater survey effort in spring compared to other seasons (Table 2). The majority (83%) of killer whale sightings were in waters less then 500 m, with 59% of sightings within 10 km of shore.

Transient killer whales were found in groups of 1-23 (mean = 7.2; mode = 5) and were encountered in all areas covered by the survey, in both offshore waters around Haida Gwaii and in inshore waters around Vancouver Island, Haida Gwaii and the northern mainland inlets (Fig. 10). Northern resident killer whales were found in groups of 3-30 animals (mean = 11.9; mode = 7) and were encountered primarily along the northern mainland coast and inlets, although one group was encountered in Johnstone Strait and four groups in Dixon Entrance (Fig. 10). Southern residents were encountered once; a group of 35 individuals was sighted north of Brooks Peninsula.

3.2.10 False killer whale

The false killer whale is a medium sized toothed whale that is found in tropical to temperate waters throughout the world. Although generally confined to warmer waters, it occasionally ranges to higher latitudes. In the northeastern Pacific, waters off BC appear to be at or beyond the northern extremity of its range and sightings are rare. All sighting records in BC are since 1987, when a group of false killer whales strayed into nearshore waters (Stacey and Baird 1991). Most or all sightings since then may be related to this original group. The species is considered by COSEWIC to be Not at Risk in Pacific Canadian waters.

A single false killer whale was seen during survey 04-3 (August) south of Calvert Island approximately 8 km from the closest shoreline (Fig. 11). This was likely a solitary individual that was found in waters of the southern Strait of Georgia for many years then wandered north to Southeast Alaska during summer, 2004 (Cetacean Research Program, unpubl. data).

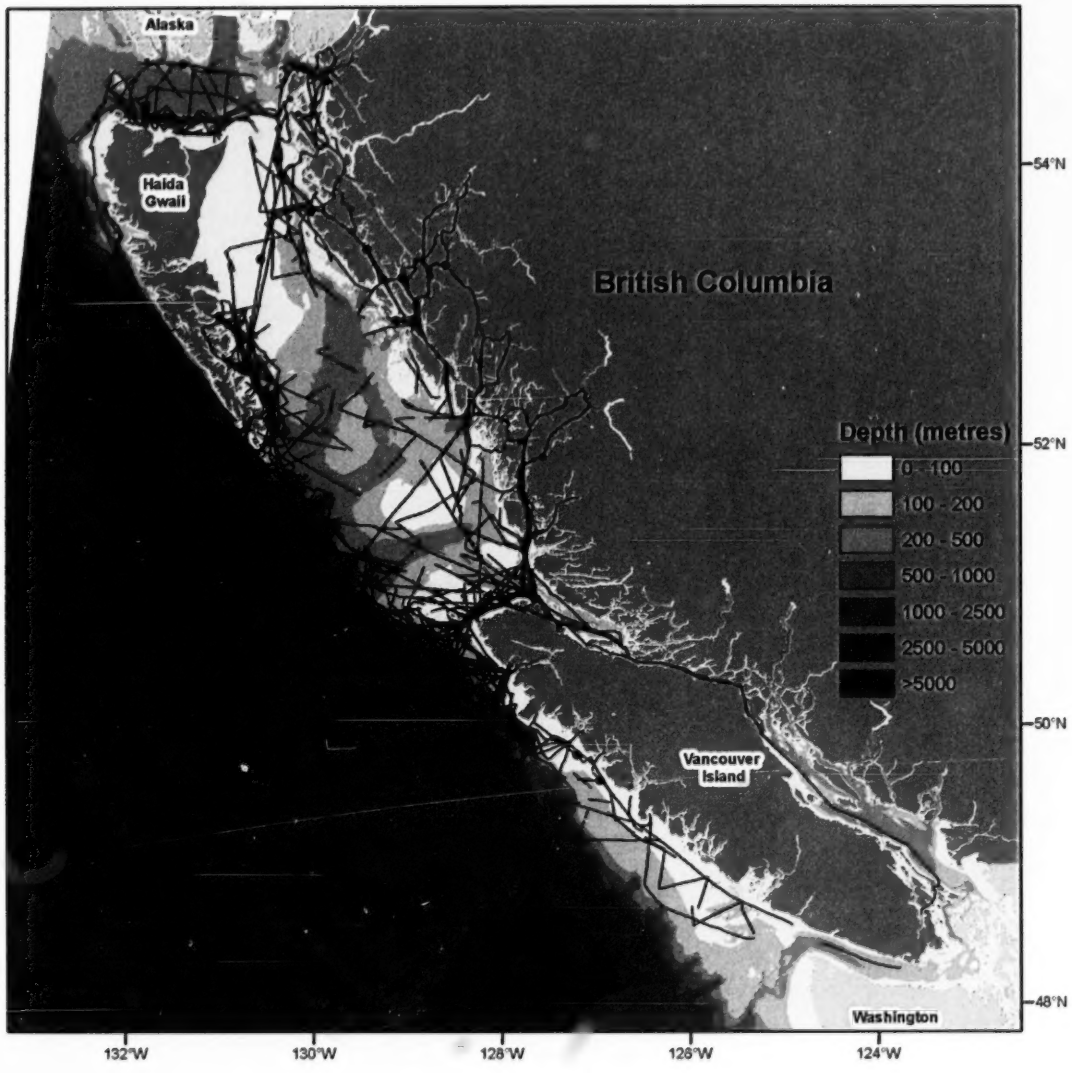

Figure 10. Sightings of transient killer whales (black dots, n = 36) and resident killer whales (red dots, n = 21) for all surveys.

Table 9. Summary of killer whale sightings. Killer whale lineage (or 'ecotype') is denoted as Res (Resident; NR = northern resident population, SR = southern resident population), Trans (Transient), or UnID (Unidentified). Dates and other details for each survey are provided in Table 1.

Survey	Sightings			Individuals			Lineage		
	n	Per 100 km	Per effort hr	n	Per 100 km	Per effort hr	Res	Trans	UnID
02-01	2	0.12	0.02	5	0.30	0.05		2	
02-02	1	0.09	0.01	3	0.28	0.03			1
03-01	12	0.39	0.06	98	3.22	0.52	5 NR	5	3
03-02	2	0.21	0.02	13	1.40	0.15			2
03-06	4	0.45	0.06	52	5.86	0.77	4 NR		
04-02	10	0.49	0.07	84	4.12	0.61	3 NR	7	
04-03	1	0.12	0.01	8	0.95	0.11		1	
04-04	0	0.00	0.00	0	0.00	0.00	-	-	-
05-01	6	0.33	0.06	40	2.21	0.38	3 NR	3	
05-02	1	0.12	0.01	10	1.24	0.13		1	
06-01	1	0.09	0.02	15	1.30	0.25		1	
06-02	8	0.25	0.05	69	2.16	0.43	1 SR	3	4
06-03	4	0.53	0.06	33	4.38	0.53	2 NR	2	
06-04	1	0.14	0.03	21	2.95	0.56	1 NR		
07-01	0	0.00	0.00	0	0.00	0.00	-	-	-
07-02	7	0.26	0.05	32	1.19	0.22		6	1
07-03	4	0.23	0.04	42	2.38	0.45		4	
07-04	1	0.06	0.01	6	0.37	0.07		1	
08-01	1	0.06	0.01	2	0.12	0.02			1
08-02	0	0.00	0.00	0	0.00	0.00	-	-	-
08-03	3	0.40	0.08	45	5.97	1.20	2 NR		1
Overall	69	0.23	0.04	578	1.93	0.32	1 SR 20 NR	36	13

3.2.11 Northern right whale dolphin

The northern right whale dolphin is widespread in temperate waters of the North Pacific. It is distinguished by its slender, elongate body and lack of a dorsal fin. It is considered to be one of the most abundant oceanic dolphins in the North Pacific, but only 17 occurrences of the species in Canadian waters have been published (Pike and MacAskie 1969; Baird and Stacey 1991a). These occurrences were concentrated off the southern BC coast, suggesting that these waters may be near the northern extremity of its normal range (Baird and Stacey 1991a). Northern right whale dolphins are considered by COSEWIC to be Not at Risk in Pacific Canadian waters.

Northern right whale dolphins were sighted on five occasions, each time in association with Pacific white-sided dolphins. Sightings were 10-35 km from shore in shelf break waters (75-1,700 m deep) off northwestern Vancouver Island (Fig. 11).

Minimum group size was 20 animals, although three of the five sightings consisted of 200 or more individuals.

3.2.12 Pacific white-sided dolphin

The Pacific white-sided dolphin is one of the most widely distributed and abundant small cetaceans in the North Pacific. The species is restricted to temperate waters and ranges across the North Pacific as far north as the Aleutian Islands. It is a year-round resident of both pelagic and nearshore waters in BC. It is a highly gregarious species and may form groups of over 1,000 animals. The species' abundance in inshore BC waters appears to have increased since the mid-1980s, possibly as a result of shoreward shift in distribution (Heise 1997). The Pacific white-sided dolphin is considered by COSEWIC to be Not at Risk in Pacific Canadian waters.

Pacific white-sided dolphins were the fourth most frequently sighted species (0.61 sightings / 100 km) and were seen on every survey (Tables 4, 6). There was a total of 183 sightings (5% of total) with an estimated 8,991 individuals, representing 51% of all animals seen on all surveys. Group size ranged from 1-1,500, although 80% of groups had fewer than 50 animals (mode = 3). Sightings of groups of 100 or more were reported 22 times, with one sighting of an estimated 1,500 individuals.

Pacific white-sided dolphins were generally coast wide in distribution with sightings occurring offshore, around Haida Gwaii, and in coastal inlets (Fig. 11). However, none was seen south of 49° N on either side of Vancouver Island. Most sightings (77%) were within 20 km of land, although sightings occurred as far as 87 km offshore. Average depth during sightings of Pacific white-sided dolphins was approximately 300 m (range = 28 to 2,000 m), with 85% of sightings occurring in less then 500 m.

3.2.13 Risso's dolphin

The Risso's dolphin is a large dolphin that is distributed world-wide in tropical and temperate waters. In the northeastern Pacific, the waters off BC appear to be the northern most extent of its range (Baird and Stacey 1991b). Risso's dolphins are commonly seen off California and are thought to shift northward to continental shelf and slope waters off Washington and Oregon during warm water months (Carretta et al. 2009). Only 21 published records of Risso's dolphins exist for BC waters (Baird and Stacey 1991b). The Risso's dolphin is considered by COSEWIC to be Not at Risk in Pacific Canadian waters.

There were two sightings of Risso's dolphins during our surveys. Group sizes were four and seven (Table 6). The first sighting on survey 06-3 (summer) was between Cape Scott and Cape St. James (Fig. 11). The second sighting was offshore of Kyuquot, Vancouver Island. These two sightings were approximately 33 km (230 m depth) and 38km (930 m depth) from shore, respectively.

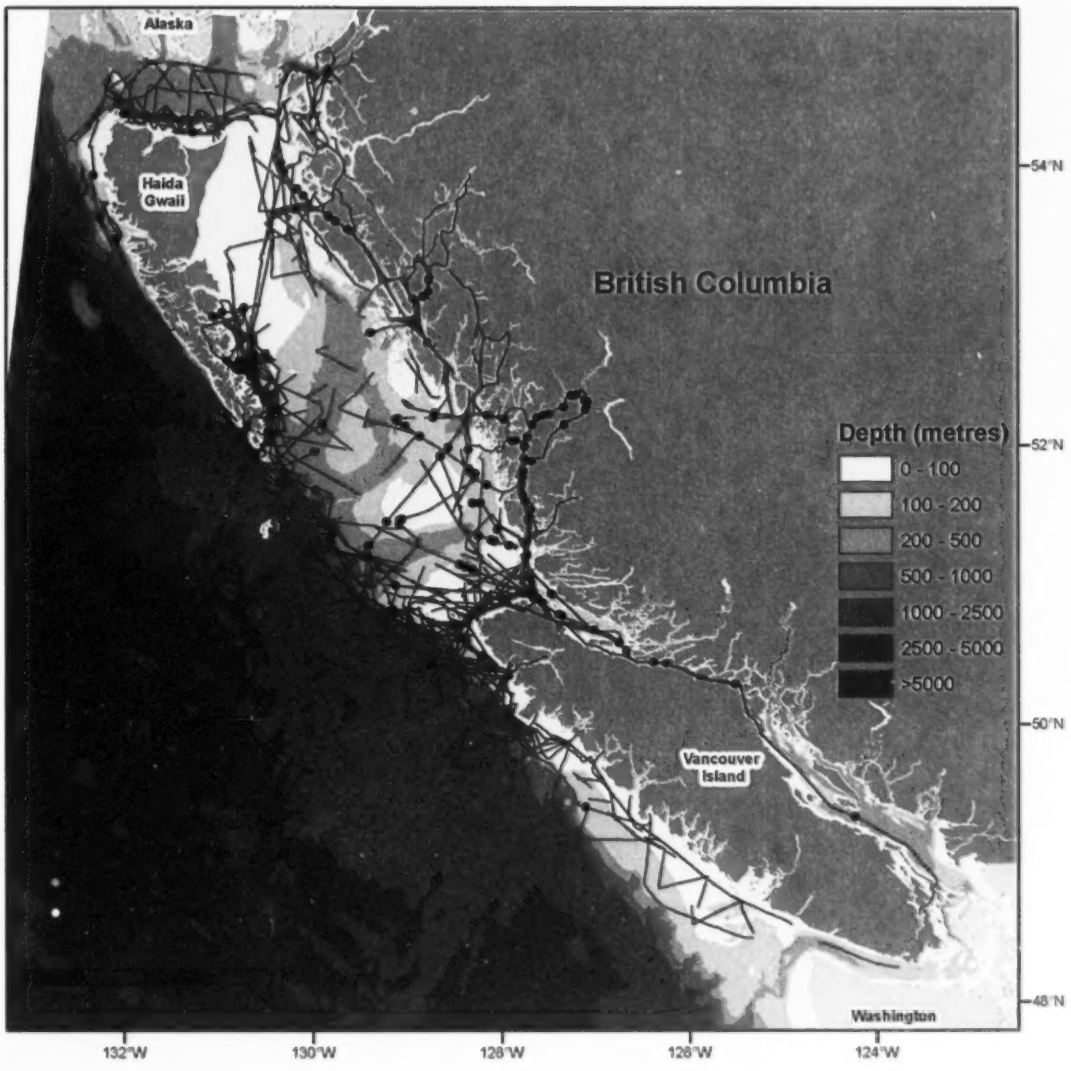

Figure 11. Sightings of Pacific white sided dolphins (black dots, n = 183), northern right whale dolphins (red dots, n = 5), Risso's dolphins (green dots, n = 2), and false killer whale (yellow dot, n = 1) for all surveys.

3.2.14 Dall's porpoise

The Dall's porpoise is found in cool temperate offshore and coastal waters of the North Pacific and adjacent seas. It is one of the most abundant and widely distributed cetaceans in the North Pacific, with an abundance likely exceeding 1 million animals. It is a moderately gregarious species, most often found in groups of 20 or less (Jefferson 2009). In coastal waters of the northeastern Pacific, Dall's porpoise range from northern Baja California to the Bering Sea. The Dall's porpoise is considered by COSEWIC to be Not at Risk in Pacific Canadian waters.

Dall's porpoise was the second most frequently encountered species, after humpback whales, and was seen on all surveys. A total of 482 sightings (14% of total) and 2,098 individuals (12% of total) were recorded (Tables 5 and 6). Dall's porpoises were sighted on each survey at an overall rate of 1.61 sightings / 100 km. Typical group size was 4-5 individuals (range = 1-50; mode = 2) and only 10 sightings were comprised of more than 15 animals.

Dall's porpoises were distributed widely in both inshore and offshore waters (Fig. 12). Average depth of Dall's porpoise sightings was just under 700 m. Approximately 60% of sightings were within 20 km of shore.

3.2.15 Harbour porpoise

The harbour porpoise inhabits cool temperate coastal waters of the northern hemisphere. In the northeastern Pacific, the species is found from Point Conception, California to the Bering Sea (Carretta et al. 2009). The species prefers shallow nearshore waters though it may also be found in deeper areas on the continental shelf. The harbour porpoise is listed by the SARA as Special Concern in Pacific Canadian waters because of its apparent sensitivity to human activities and vulnerability to incidental entanglement and mortality in fishing nets.

A total of 73 sightings of harbour porpoise were recorded during 17 of the 21 surveys and during every season. Group sizes ranged from 1-25 (mode = 1; median = 2), with 84% of sightings consisting of three animals or fewer.

The majority (88%) of harbour porpoise sightings were within 20 km of shore, in shallow inshore waters (average depth 195 m) around Vancouver Island, Haida Gwaii, and the mainland inlets (Fig. 12), although there were some exceptions. Several animals were seen up to 47 km offshore, and in waters up to 1,300 meters deep.

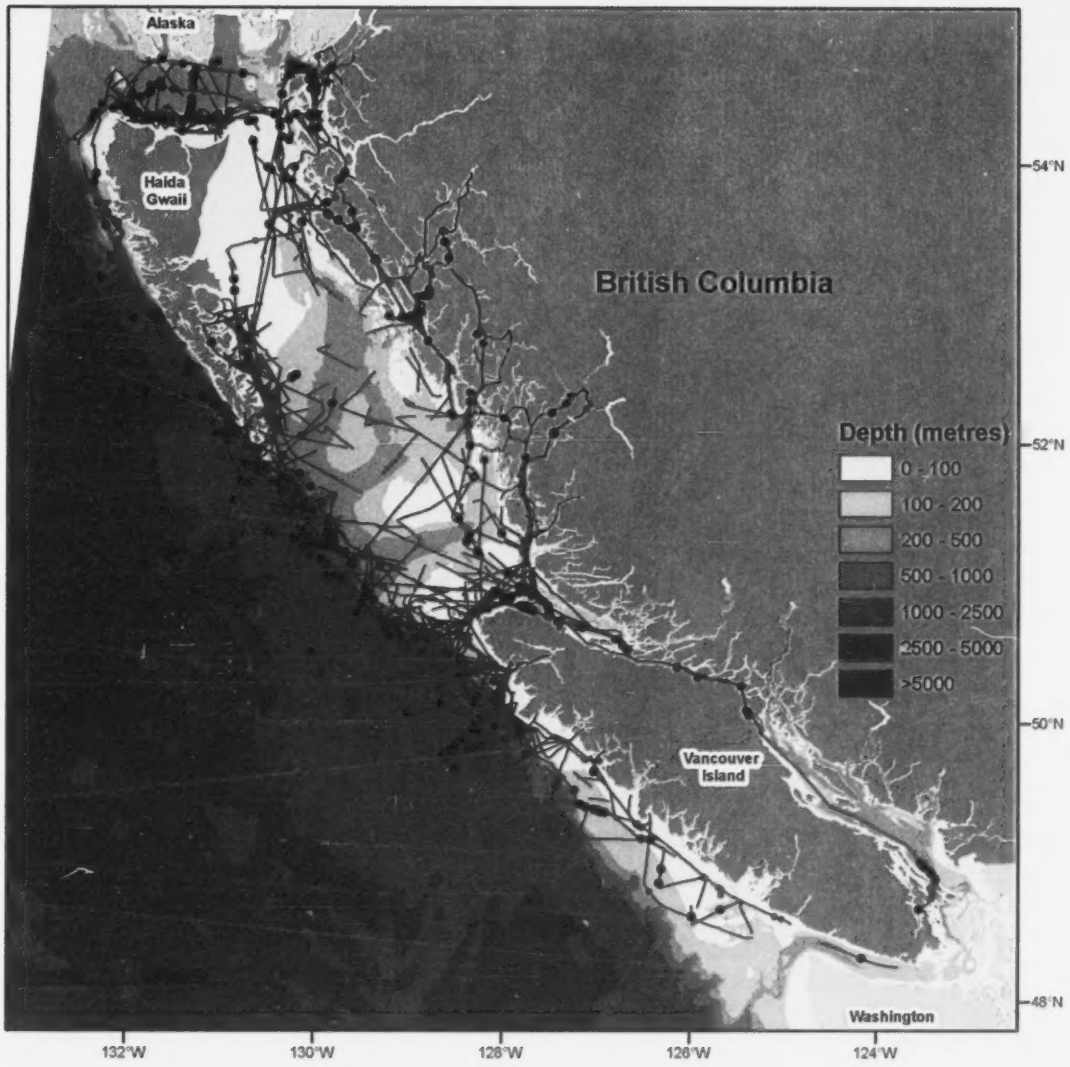

Figure 12. Sightings of Dall's porpoises (black dots, n = 482) and harbour porpoises (red dots, n = 73) for all surveys.

4.0 CONCLUSIONS AND FUTURE DIRECTIONS

Sightings made during these surveys, together with ancillary data collected from small vessels deployed from survey ships, have yielded significant new information on the current status of cetaceans off the Pacific coast of Canada. Although this has helped to inform species at risk recovery initiatives (e.g., Ford et al. 2009, Nichol et al. 2009), considerably greater survey effort is needed to obtain a more comprehensive understanding of the seasonal distribution, abundance and habitat use patterns of cetaceans throughout Canadian Pacific waters.

Due to constraints on the amount of Canadian Coast Guard ship time available each year, our survey effort was by necessity focused on known or suspected areas of importance to priority SARA-listed species, including killer whale, humpback whale, fin whale, and blue whale. As a result, survey effort was not uniformly distributed throughout the study area and significant portions of coastal waters received relatively little coverage. In addition, very little survey effort was applied in waters beyond 50 km of the continental shelf break, and none beyond 150 km offshore. Substantial numbers – if not the majority – of blue, fin and sei whales killed by commercial whalers off the BC coast were taken in these offshore waters (Gregr et al. 2000; Gregr and Trites 2001). It is probable that whales continue to use these offshore habitats today, yet no surveys have been conducted in those areas. Our survey effort was also not uniformly distributed across the seasons. Spring and summer received the majority of survey effort while fall and winter surveys were few in number and confined mostly to nearshore waters.

A systematic line-transect survey of the entire Canadian exclusive economic zone (EEZ), which extends to 370 km (200 nm) offshore, would be needed to estimate the current abundance of cetaceans off Canada's west coast. This type of intensive survey is undertaken off the mainland coast of the US every few years, and each survey requires many months of dedicated research ship time (Barlow and Forney 2007). Until such time as this level of ship time support becomes available in Canada, our survey efforts off the BC coast will continue to focus on known 'hot spots' for priority SARA-listed species. Survey objectives will include the assessment of trends in population density (through stratified line-transect sampling and/or individual photo-identification) and the identification of biophysical covariates of habitat use patterns. This information will be needed to assess progress towards meeting goals and objectives of DFO Recovery Strategies and Action Plans and to identify critical habitats for these endangered and threatened species.

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APPENDIX A: Place Names

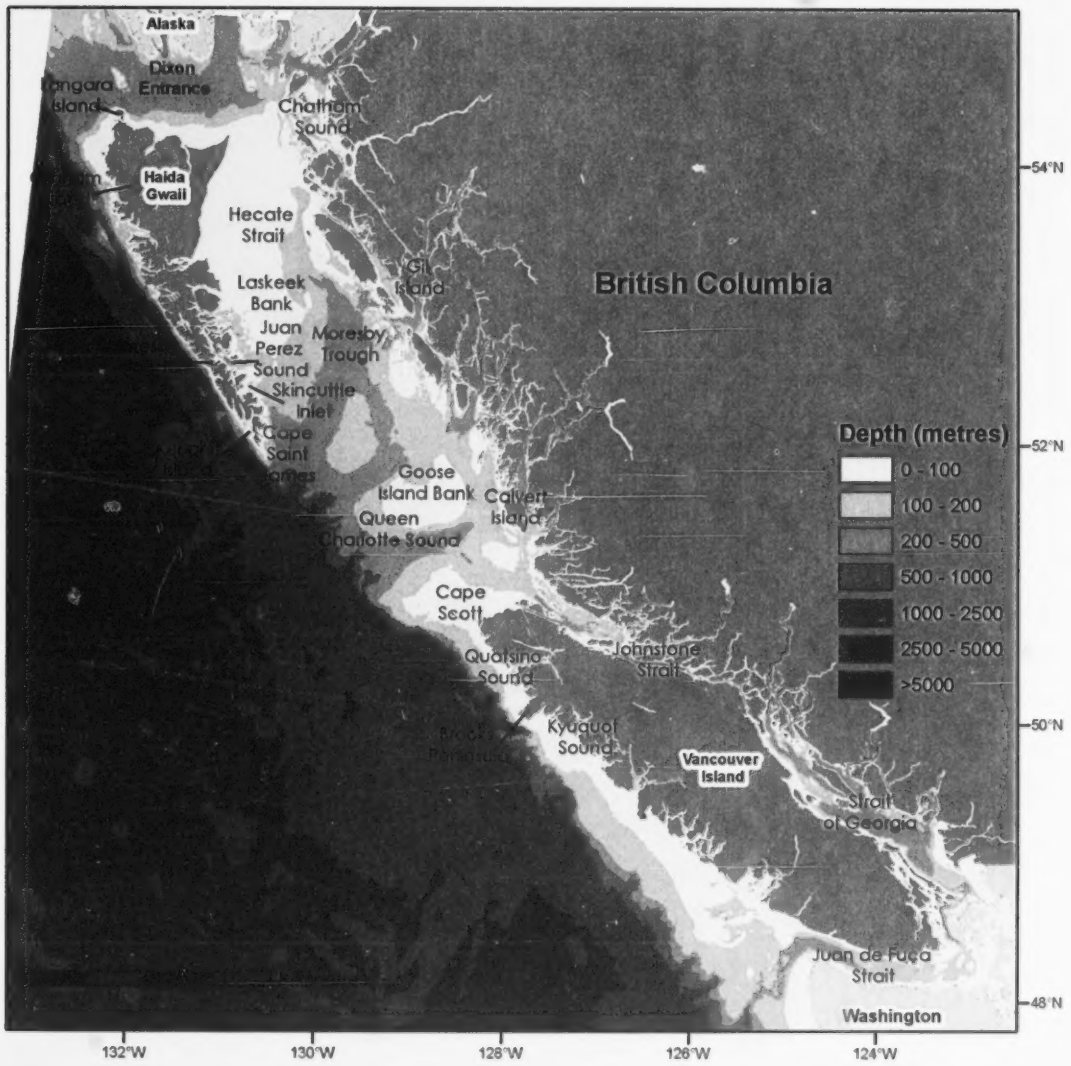

Figure A-1. Place names referenced in this report.

APPENDIX B: List of Vessels and Research Personnel

Table B-1. Description of vessels used for cetacean surveys, 2002-2008.

Vessel name[a]	Length (m)	Height of eye on ship's bridge (m)	Cruising speed (knots)
CCGS John P. Tully	69	12.8	10
CCGS W.E. Ricker	58	10.9	9.5
CCGS Tanu	54.5	7.8	11
CCGS Gordon Reid	50	10	12
CCGS Vector	39	8.1	10
M/V Curve of Time	25.5	7 (est)	7

[a] CCGS vessels are operated by DFO / Canadian Coast Guard; *Curve of Time* is owned and operated by Due West Charters, Richmond, B.C.

Table B-2. Research teams on cetacean survey surveys, 2002-2008.

Survey	Vessel	Observers[a]
02-1	*Vector / Gordon Reid*	JF (CS), GE, LBL, LN, MO
02-2	*Curve of Time*	JAC (CS), LS, HK, SBC, ASC, JLH, DLC, JK
03-1	*Vector / Tanu*	JF (CS), BFO, BFA, BG, EG, GE, HK, LS, MJ, MO
03-2	*Curve of Time*	JAC (CS), MO, MB, ST, ASC, RNL, JBU
03-6	*John P. Tully*	JF (CS), MB, BG, GE, HK, MO, SS
04-2	*John P. Tully*	JF (CS), BG, GE, HK, JBL, JP, LDR, LS, MM, SS
04-3	*Curve of Time*	JAC (CS), LS, HK, SBC, ASC, JLH, DLC, JK
04-4	*John P. Tully*	JF (CS), AR, BG, LDR, LN, LS, MM, PR, RA, SS
05-1	*Vector*	GE (CS), AR, BG, HK, LDR, LN, LS, MM
05-2	*Curve of Time*	JAC (CS), LS, AR, ASC, JLH, ALK, SBC, CAC,
06-1	*John P. Tully*	JF (CS), GE, BG, MB, MM
06-2	*Tanu*	GE (CS), LN(CS), AR, HK, JT, LDR, LS, MM, RA,
06-3	*Curve of Time*	LS, HK, MB, CRC Research Crew
06-4	*John P. Tully*	JF (CS), BG, GE, JB, JT, LDR, MM, RA, WS
07-1	*W.E. Ricker*	JF (CS), GE (CS), BG, CL, CM, GE, JB, JF, JS, JT, LBL, MM, RA, TS
07-2	*John P. Tully*	JF (CS), AR, BG, CL, CM, GE, JT, JW, LN, MM, RA, TL, VD
07-3	*John P. Tully*	JF (CS), AP, AR, BP, BW, HK, JWE, RA, JAC, JLH. BAD. ASC. JB
07-4	*Gordon Reid*	GE (CS), LN (CS), AP, BG, JT, KO, MB, MM, RA, TL
08-1	*John P. Tully*	GE (CS),BG, BK. BW. CN, CS, JT, MM, MO, RA
08-2	*John P. Tully*	JF (CS), AR, BG, BW, CS, GE, HK, HN, JS, JT, JW, KC, LDR, MM, MW, RA, RR, SR, TL
08-3	*Tanu*	GE (CS), CS, HI, HK, JT, RA

[a] Chief Scientist designated by (CS). ALK = Amber Klimek; AP = Alana Phillips; AR = Andrea Rambeau; ASC = Alexei Calambokidis; BADE = Bethany Diehl; BFA = Brian Falconer; BFO = Barry Ford; BG = Brian Gisborne; BK = Barb Koot; BP = Bruce Paterson; BW = Brianna Wright; CAC= Carlos Aguilera Calderon; CL = Chantal Levesque; CN = Cameron Noble; CM = Christie McMillan; CRC = Cascadia Research Collective ; CS = Chelsea Stanley; DLC = Dominique Camacho; EG = Ed Gregr; GE = Graeme Ellis; HK = Hitomi Kimura; HK = Heidi Krajewsky; HN = Hiromi Naito; JAC = John Calambokidis; JB = Jim Borrowman; JBL = John Blackburn; JBU = Jessica Burtenshaw; JF = John Ford; JH = Jessie Huggins; JK = Jens Koblitz; JT = Jared Towers; JS = Jan Straley; JSC = Jake Schweigert; JW = Jane Watson; JWE = Jody Weir; KL = Katie Luxa; LAS = Lisa Schlender; LBL = Lance Barrett-Lennard; LDR = Luciano Dalla Rosa; LN = Linda Nichol; LS = Lisa Spaven; JP = June Petzer; MJ = Marilyn Joyce; MM = Mark Malleson; MO = Miriam O; MB = Melissa (Webb)

Boogaards; OT = Oscar Torres; PGA = Paulina Godoy; PR = Philippe Rouget; RA = Robin Abernethy; RNL = Randy Lumper; RR = Rhonda Reidy; SBC = Sherwin Cotler; SN = Sandy Neal; SS = Silvia Scali; ST = Scott Toews; TL = Tatiana Lee; TS = Tara Stevens; VD = Volker Deecke, VO = Vincent O; WS = Wendy Szaniszlo; YO = Yuki Ogino; ZMF = Zoe Froyland

APPENDIX C: Definitions of fields and codes used in data collection, 2002-2005

Data were entered onto data sheets by the data recorders when available, or by the primary observer(s) (Table C-1). The following is a summary of definitions of the data fields and codes used in the surveys.

On Duty	
Data Rec	Initials of data recorder
Observers (PORT + STBD)	Initials of on-duty observers stationed on port and starboard observation posts
Effort	
ON	Observers are on shift, weather is favourable (<Beaufort 5 and/or visibility > 1 nm) and the ship is traveling at >5 kts on a transect line
OFF	No observers on duty, poor weather (≥ Beaufort 5 and/or visibility < 1 nm), ship slows to <5 kts speed, or ship stopped while small boat(s) launched
Passing	On transect line
Closing	Off transect line; closing on a sighted group to investigate
Deck / Meth	Location of on-duty observers / equipment employed for scanning
Ship Position	
Time	From stopwatch in bridge
Latitude / Longitude	From radar screen / GPS; recorded in decimal minutes to 2 decimal places (Lat = DD° MM.MM; Lon = DDD° MM.MM)
Ship Course	From radar screen / GPS
Ship Speed	From radar screen / GPS, in nautical miles per hour (kts)
Depth	From depth sounder, in metres
Viewing Conditions	
Visibility	Maximum sighting distance from bow as estimated by observers, in nautical miles
Precipitation	MI = mist; LR = light rain; HR = heavy rain; LF = lifted fog; HF = heavy fog; HZ = haze; CL = clear / sunny; PC = partly cloudy; OV = overcast
Sea State	Sea state as defined by the Beaufort Scale, estimated by on-duty observers: 0 = sea smooth and mirror-like 1 = scale-like ripple with no foam

Sea State cont.

2 = small wavelets, smooth crests (wind 4-6 kts)
3 = large wavelets, some breaking crests (wind 7-10 kts)
4 = small waves, frequent white foam crests (wind 11-16 kts)
5 = moderate waves, many whitecaps (wind 17-21 kts)

Swell

Estimated height of waves in metres

Sighting Information

Sighting #

Consecutive # (per survey) for each sighting made by an on-duty or auxilliary observer. No sighting numbers were assigned for opportunistic sightings or sightings past 90° from the bow.

Species

Best description of marine mammal species, as narrowly defined as possible.

HW	Humpback whale
FW	Fin whale
SW	Sei whale
BW	Blue whale
MW	Minke whale
GW	Grey whale
SPW	Sperm whale
KW	Killer whale
DP	Dall's porpoise
HP	Harbour porpoise
PWS	Pacific white-sided dolphin
CD	Common dolphin
NRWD	Northern right whale dolphin
FKW	False killer whale
BBW	Baird's beaked whale
CBW	Cuvier's beaked whale
UC	Unknown cetacean (any whale, dolphin or porpoise)
UR	Unknown rorqual (baleen whale)
ULW	Unknown large whale (possible HW, FW, SW, BW or SPW)
USW	Unknown small whale
UDP	Unknown dolphin or porpoise
SSL	Steller sea lion
NFS	Northern fur seal
HS	Harbour seal
NES	Northern elephant seal
SO	Sea otter

Cue	Visual trigger that alerted the observer to sight the animal; BO = body; BL = blow; SP = splash; SH = ship; OT = other
Method	Equipment used to sight the animal; BI = binoculars; BE = "big eyes"; NE = naked eye
Bearing	Angle from the bow of the ship (0º) to the animal sighted.
Reticles	Number of reticle lines down from the horizon, to the best accuracy available according to weather conditions
Group size (#)	Best estimate of group size by on-duty observer
Group size (min / max)	Best estimate of range of group size by on-duty observer
Notes	Any relevant comments that may help to better explain the data recorded, such as: small boat or hydrophone deployment; slowing or stopping for short periods; reticles read from shore; animal behaviour or description; photos taken (frames, photographer)

Table C-1. Example of data sheet used for documenting effort, viewing conditions and sighting information.

ON DUTY			EFFORT			SHIP POSITION						VIEWING CONDITIONS				SIGHTING INFORMATION									
Data Rec	Observers		ON / OFF	Pass/ Close	Deck/ Meth	Time	Lat	Lon	Ship Course	Ship Speed	Depth (M)	Vis	Prec	Sea State	Swell (m)	Sight #	Species	Cue	Meth	Bear to	Ret / Dist(m)	Group Size			Notes
	PORT	STBD																				#	Min	Max	

APPENDIX D: Definitions of fields and codes used in Logger 2000 during 2006-2008

Effort Data	
Effort segment	- Automatically filled
Date & Time	- Automatically filled from GPS NEMA string
Position	- Automatically logged from GPS NEMA string every 30 seconds or when new sighting is entered.
Event	- Begin effort - Observer rotation - Weather update/change - Change effort (activity) - End effort
Activity	- On effort: Observers are on shift, weather is favorable (<Beaufort 5 and/or visibility > 1 nm) and the ship is traveling at >5 kts on a transect line - On effort (closing): Off transect line; closing on a sighted group to investigate - Off effort
Platform	- Monkey's Island - Bridge
Observer position	- Port - Starboard - Data Recorder
Instrument	- 7x50 Fujinon binoculars - Big eye binoculars
Sighting conditions	
Beaufort sea state	- 0: Glassy mirror-like - 1: Scale ripples - 2: Small wavelets - 3: whitecaps, 1-5/sec - 4: frequent whitecaps - 5: many whitecaps/spray
Swell	- 0: no swell - 1: Low <1m short/average - 2: Low <1m long - 3: Moderate <2m short/average - 4: Moderate <2m long - 5: Big 2-4m, short/average - 6: Big 2-4m, long - 9: Confused
Visibility	- Excellent: Clear horizon, favorable lighting

	- Good: Visible horizion - Fair: no horizon, > 3nm visibility - Poor: no horizon, < 3nm visibility
Sightability (porpoise)	General impression of conditions for spotting porpoise - Excellent - Good - Moderate - Poor
Glare intensity	- 0: None - 1: Mild - 2: Moderate - 3: Severe
Glare left limit	- Bearing of the left edge of the glare (+/- 90 degrees) from the bow
Glare right limit	- Bearing of the right edge of the glare (+/- 90 degrees) from the bow
Weather conditions	- CL: Clear blue sky (0-20%) - PC: Partly cloudy (21-80%) - C: Cloudy (81-99%) - OV: Overcast (100%) - MI: Mist - F: Fog - LF: Lifted Fog - HF: Heavy Fog - FP: Fog Patches - LR: Light Rain - HR: Heavy Rain - HZ: Haze - SN: Snow
Sea Surface Temperature (Celcius)	- Recorded when available from ships instrumentation
Wind Speed (Knots)	- Relative wind speed read from ships instrumentation
Wind Direction	- Relative wind direction (+/- 90 degrees) read from ships instrumentation
Comments	- Used as necessary to further contribute to the descriptions of sighting conditions.

Sighting Data

Sighting Number	- Consecutive numbers assigned automatically when a new sighting is reported
Time & Position	- Recorded automatically at the time of which the sighting is reported to data recorder and entered in Logger by data recorder.
Ship's heading	- Ships true heading at exact time a new sighting is reported. Read from ships instrumentation.

Angle and Distance Data

Bearing	- Angle from the bow of the ship (0°) to the animal sighted. Read from angle board or pelorous.
Reticle	- Number of reticle lines down from the horizon, to the best accuracy available according to weather conditions.
Reticle line	- HO: Horizon - LA: Land
Radial Distance	- Estimated distance to sighting when to close to measure reticles. Estimates are in metres. -

Observer information

Side	- Port - Starboard
Observer	- On effort observer who observed and reported the sighting.
Initial cue	This describes what the observer saw when initially detecting the sighting - BL: Blow - BO: Body - F: Fluke - SP: Splash - BR: Breach - BI: Birds - U: Underwater

Method

This describes what instrument the observer was using when detecting the animal

- E: Naked eye
- Bi: 7X50 Binoculars
- BE: 25X150 Big Eyes

Species

Best description of marine mammal species, as narrowly defined as possible.

HW	Humpback whale
KW	Killer whale
FW	Fin whale
SW	Sei whale
BW	Blue whale
MW	Minke whale
GW	Grey whale
SPW	Sperm whale
DP	Dall's porpoise
HP	Harbour porpoise
PWS	Pacific white-sided dolphin
NRWD	Northern right whale dolphin
FKW	False killer whale
BBW	Baird's beaked whale
CBW	Cuvier's beaked whale
RD	Risso's dolphin
LHW	Like Humpback whale
LFW	Like Fin whale
LM	Like Minke whale
UC	Unknown cetacean
BS	Unknown rorqual (baleen whale)
UW	Unidentified whale
ULW	Unidentified large whale
ULBW	Unidentified large baleen whale
USW	Unidentified small whale
UDP	Unknown dolphin or porpoise

Animals Best

- Best estimate of group size by on-duty observer.

Animals min

- Minimum estimate of range of group size by on-duty observer.

Animals max

- Maximum estimate of range of group size by on-duty observer.

Calves	- Indicate number of calves present (recorded only if noted, not for every sighting)
Comments	Any relevant comments that may help to better explain the data recorded, such as: small boat or hydrophone deployment; slowing or stopping for short periods; reticles read from shore; animal behaviour or description; photos taken (frames, photographer)